Study of Impacts Caused by Exempting Currently Non-exempt Maine Interstate Highways From Federal Truck Weight Limits

Final Report

June 2004

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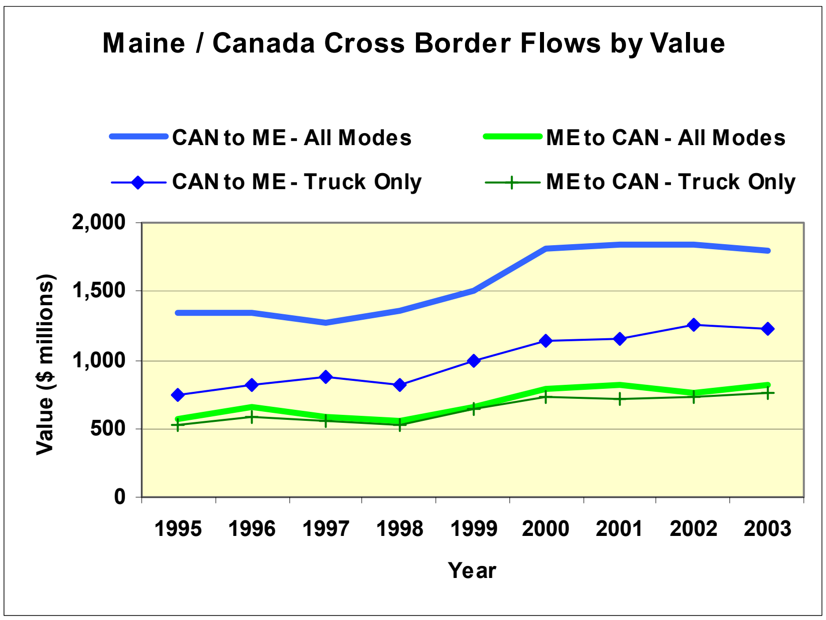
Introduction

The United States (U.S.) economy has become increasingly reliant on international trade and for regional economies to excel in this trade environment U.S. companies must remain competitive with their international counterparts. To participate in the international marketplace, local and regional economies must be supportive of modern supply-chain logistics and competitive transportation options. Integrated transportation systems that support efficient goods movement and roadway policies that maximize the safety, and efficiency of freight transportation and international commerce are keys to competing.

Since the implementation of the North America Free Trade Agreement (NAFTA), Canada has assumed the role as the primary trading partner with the United States. The chart in **Exhibit 1** displays the growth in trade moving across the border between Maine and Canada. Based on figures for the first eleven months of 2003, imports from Canada to Maine will remain just under $2 billion, with about one-half of these goods moving by truck. Exports from Maine in to Canada are worth just over $800 million, with nearly all of this trade moving by truck.

Exhibit 1: U.S. Merchandise Trade with Canada 1994- 2002



In 1998, 92 percent of all freight (by weight) originating in Maine was transported by truck 75 percent of all originating truck flows moved 250 miles or less. While intermodal rail and water facilities offer some alternatives, the nature of the Maine's economy requires heavy reliance on truck transport. The Heavy Haul Truck Network Study[1] found that truck traffic is anticipated to grow by nearly 80 % on average across the state by 2015. Growth rates for individual counties were as high as 176% on some roadway classes. In addition, a recent forecast completed by the Federal Highway Administration anticipates truck traffic due to trade with Canada to grow by 3.1% annually through 2020.

Currently, U.S. federal limits on truck weight are among the lowest among industrialized nations of the world. Following is a sample of weight limits for regular truck operations in other countries:

- Canada
  - 6-axle TST – 43,500 kg (95,900 lbs.)
  - 8-axle B-train double – 62,500 kg (137,785 lbs.)
- Mexico
  - 6-axle TST – 48,500 kg (106,920 lbs.)
  - 8-axle B-train double – 60,500 kg (133,375 lbs.)
- European Commission – six axle TST - 44,000 kg (97,000 lbs.)
- Australia – B-train doubles – 62,500 kg (137,785 lbs.)

Maine's freight transport system is vital to regional mobility and productivity, and ultimately economic development. Hence, an efficient and cost effective transport system is vital to the competitive position of businesses and industries competing with international trading partners. Federal regulations govern the weight and size of trucks on the Interstate Highway System in the U.S. Regulations placed on truck size and weight carry implications for highway safety, infrastructure preservation and the competitive position trucks against other modes, primarily railroads. Federal regulation of truck size and weight is of particular importance to U.S. border-states under the North American Free Trade Agreement. Both Canada and Mexico allow significantly higher gross weights for trucks operating in their counties. As a result, U.S. companies competing against cross-border rivals in traditional resourced based industries, where margins are often low, find it difficult to compete against foreign companies that are afforded more efficient truck transport.

Background

In 1913 Maine became one of the first states to place limits on truck weight to protect highway pavements and bridges. The federal government first began regulating truck size and weight (TS&W) limits on the Interstate Highway System in 1956, establishing a maximum gross weight limit on Interstate Highways of 73,280 lbs.. Those state's with higher weight limits prior to July 1, 1956, were allowed to retain those higher weight limits as "grandfathered" rights. In 1975 Congress increased the allowable gross vehicle weight on the Interstate System to 80,000 lbs.. Since 1982, there have been no changes in federal weight limit laws. Title 23 USC, 127 provides the following weight limits on the Interstate Highway System:

- Single axle weight limit: 20,000 pounds (lbs.)
- Tandem axle weight limit: 34,000 lbs.
- Gross vehicle weight limit: 80,000 lbs.
- All vehicle combinations must comply with the federal bridge formula

Truck Weight Limits in Maine

Exhibit 2: Maine Weight Limits

Axle Configuration	Maine	
	Special	All Other
Single axle limit	24,200 lbs.	22,400 lbs.
Tandem axle limit		
5 axle combination	44,000 lbs.	38,000 lbs.
6 axle combination	44,000 lbs.	41,000 lbs.
Tri-axle weight limit		
5 axle combination	54,000 lbs.	48,000 lbs.
6 axle combination	54,000 lbs.	50,000 lbs.
GVW limit		
5 axle combination	88,000 lbs.	80,000 lbs.
6 axle combination%	100,000 lbs.	100,000 lbs.

In 1998, The Transportation Equity Act for the 21st Century (TEA-21) provided an exemption from the federal gross vehicle weight (GVW) limit on the Maine Turnpike and a portion of Interstate – 95 in Kittery. The remaining Interstate routes in Maine, I-295, I -395 and large portions of I-95 remain subject to the federal GVW limit of 80,000 lbs. The exempt portion of I-95 and all other state highways allow a GVW of 100,000 lbs. on a six-axle tractor semi-trailer (TST) with sufficient spread between axles. As a result, heavy combination trucks that would otherwise be through traffic on the Interstate system divert to state highways upon reaching the non-exempt portion of I-95.

In 2002, the Maine Department of Transportation (MDOT) contracted with Wilbur Smith Associates to examine the impact a federal weight exemption on currently non-exempt portions of Maine's Interstate System would have on safety, pavement and bridges.

Study Approach and Report Organization

The primary objective for this study is to determine the safety consequences, infrastructure costs and related social and economic impacts that would result from an exemption to all non-exempt Interstate Highways in Maine. To conduct the analysis the current condition of allowing trucks in excess of 80,000 lbs. only on the Maine Turnpike and state highways is compared to an Interstate exempt scenario. The analysis concentrates on the projected fiscal and safety impacts to the non-exempt portions of Maine's Interstate Highways that would assume heavy truck traffic if the current federal weight limit is lifted. In presenting the results of this analysis, the report is organized as follows:

1. **Network Development:** Because the infrastructure and safety impacts analysis were based on the comparison of the base condition network and the study condition network (all Maine Interstate System exempt), an understanding of the data used in modeling the networks is crucial to understanding the subsequent analyses. While some details about the network development are included as appendices to this report, additional documentation about the modeling process steps can be found in two Technical Memorandums prepared as interim reports during the course of this study.

2. **Safety Analysis:** The existence of a detailed, geo-coded crash database in Maine allowed the Study Team to examine the crash experience of five and six-axle vehicles across highway classes in Maine. Summary crash data for Maine is also presented within the context of the national crash experience for these vehicle types.

3. **Pavement Analysis:** Using TRANSEARCH data about heavy commodity flows, estimates of ton-miles and equivalent standard axel loads (ESALS) are modeled across the base condition network and the study network, to estimate the pavement costs associated with the weight exemption policy.

4. **Bridge Analysis:** The study analyzed a sample of representative bridges for Maine and then examined the cost impacts across all bridges on the study networks.

5. **Other Economic and Social Impacts**: This section of the report presents the results of carrier and shipper interviews, interviews with city officials in Maine and the findings of other prominent TS&W studies.

6. **Study Conclusions:** Summarizes the study findings. This section also presents several recommendations for TS&W policy on the Maine Interstate System.

Data Sources

Three principal data sources were used to understand existing truck traffic and estimate changes in truck flows due to a change in weight policy on Maine highways:

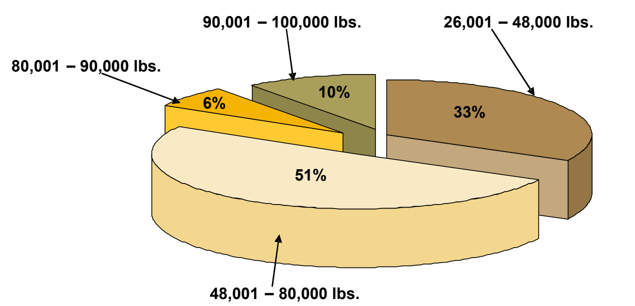
- Weigh-in-motion (WIM) sites
- Vehicle classification counts
- TRANSEARCH commodity data

These data were also supplemented with information from motor vehicle registrations, interviews with trucking firms, and discussions with weight enforcement officials.

Maine Registered Vehicle Weight

In 2002 there were 138,709 registered commercial vehicles in Maine. Nearly 90% of all registrations are single unit vehicles. More than half (57%) were registered for less than 26,000 lbs. Of the vehicles of 26,000 lbs. or more, only 3,262 (16%) were registered to exceed 80,000 lbs. These statistics reinforce that the vehicle population examined in this study represent only a fraction of the total truck population.

Commercial Vehicles Registered in the State of Maine for GVW of More than 26,000 pounds.



Source: Maine Bureau of Motor Vehicles

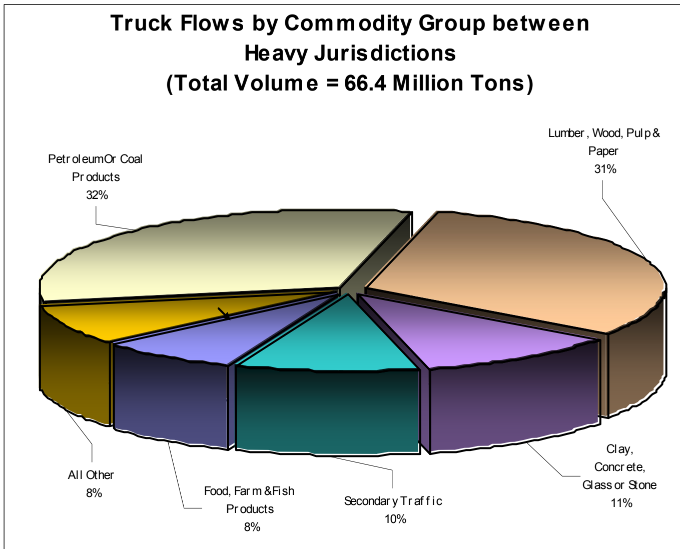
TRANSEARCH Commodity Data

TRANSEARCH is proprietary data, assembled and marketed by Reebie Associates since 1980, providing county level freight flows by mode and commodity. Considered the premier source for intercity and intra-city commodity flows, TRANSEARCH provides volumes and values by individual commodity and mode of transport throughout the U.S. Truck data are focused on the manufacturing industries, and are drawn from a sample of truck shipments by a number of major truckload and LTL carriers. TRANSEARCH is used by railroads, motor carriers, container ship lines and air cargo carriers throughout the U.S. It is also used by state and federal planning agencies, port authorities, equipment suppliers, investment banks and regulatory bodies. The dataset for this study reflects year 2000 flows. The data covered all modes and commodities. Truck movements for non-manufactured commodities, typically a weakness of the TRANSEARCH data were enhanced for this study to capture flows of raw timber products.

A first step of the analysis was to better understand existing heavy commodity origin/destination (O/D) flows using the TRANSEARCH data. The analysis focused on "heavy commodity" flows to and from jurisdictions allowing GVW in excess of 80,000 lbs. in normal operations on state or provincial networks. The analysis also focused on "Special Commodities" as defined in Maine law.

The total volume of truck flows reflected in the TRANSEARCH dataset equaled 87.4 million tons. Extracting only those truck flows to and from jurisdictions allowing a GVW in excess of 80,000, (i.e., flows to and from Canada, New Hampshire, Massachusetts, New York and within Maine), resulted in 66.4 million tons, or roughly three-quarters of all truck flows by weight*.

Exhibit 3: Commodity Shares (tons)



Source: TRANSEARCH 2000, Reebie Associates

Exhibit 3 shows the resulting flows by commodity group. Five commodity groups comprise 92% of the "high weight jurisdiction" flows by truck:

- STCC 29 Petroleum Products
- STCC 24 & 26 Lumber, Wood & Paper Products
- STCC 32 Clay, Concrete & Stone
- STCC 50 Secondary Traffic
- STCC 1, 9 & 20 Food, Fish and Farm Products

More than 95% of the "Secondary Traffic" in Maine is mixed commodities moving between warehouse facilities. Typically, mixed commodities "cube-out" (use available volume capacity) before "weighing-out" (use available payload) and for that reason STCC 50 traffic was not included among the heavy commodity groups. For additional simplification, several related commodity groups were combined and analyzed together.

Exhibit 4: Top Flows between Jurisdictions Allowing Higher Gross Vehicle Weights

Commodity	TruckTons
Petroleum Or Coal Products	21,051,444
Lumber, Wood, Pulp & Paper	20,656,432
Clay,Concrete,Glass or Stone	7,233,870
Secondary Traffic	6,768,652
Food, Farm & Fish Products	5,013,010
All Other	5,629,889

The remaining combined commodity groups: 1) Petroleum; 2) Wood & Paper; 3) Concrete and Stone, and; 4) Food, Farm and Fish Products, became the focus of heavy truck flows. Together, these groups comprise more than 80% of the tonnages moving within Maine, or between and through Maine from other heavy truck jurisdictions. The top commodities resulting from the "gross weight highway jurisdiction" filter are shown in the table of **Exhibit 5**, at a 2-digit STCC level.

* Not all jurisdictions used in the initial routing allow vehicles in excess of 80,000 lbs. on all facilities, but all have some facilities such as the Massachusetts Turnpike and New York Thruway that allow higher weight vehicles.

Special Commodities

As discussed earlier, the State of Maine allows a 10% weight allowance on 5-axle TST combinations. Special commodities are defined as:

- Materials or unset concrete intended for highway construction and carried in dump or transit-mix trucks;
- Manufacturer's concrete products;
- Raw ore from mine or quarry to place of processing;
- Unprocessed milk;
- Refrigerated products constituting the majority of products carried in a sealed vehicle;
- Building materials that absorb moisture during delivery with O/Ds within the State;
- Incinerator ash;
- Unconsolidated rock materials, including limestone, bark, bolts, sawed lumber, farm produce, road salt, soils, solid waste, sawdust, wood chips, dimension lumber, recyclable, materials, pulpwood/ firewood/logs.

Flows at a detailed commodity level were examined and filtered to determine those commodities that would likely qualify for the five axle GVW bonus. The commodity list in **Exhibit 5** is used in helping select heavy weight commodities for traffic modeling:

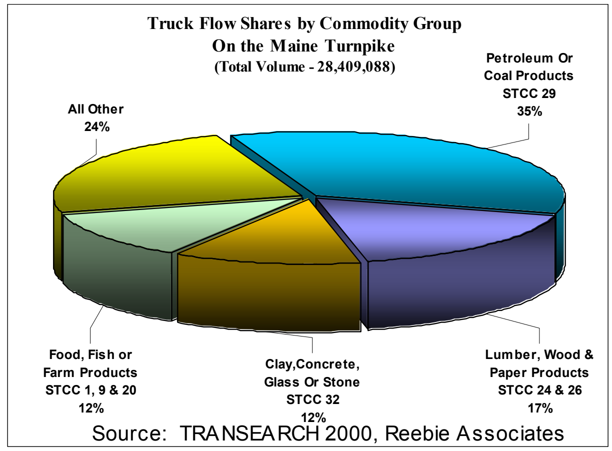
Exhibit 5: "Special Commodities" Extracted from TRANSEARCH

o Concrete products	o Maine Products
o Portland Cement	o Fresh Fish or Whale Products
o Broken stone or riprap	o Frozen Fruit, Vegetables or Juice
o Gravel or sand	o Frozen Specialties
o Dimension Stone, Quarry	o Ice, Natural or Manufactured
o Clay, Ceramic Minerals	o Forest Products
o Fertilizer Minerals – Crude	o Primary Forest Materials
o Misc. Non-metallic Minerals	o Lumber or Dimension Stock
o Clay, Brick or Tile	o Misc. Sawmill
o Ceramic Floor or Wall Tile	o Millwork
o Meat, Fresh or Chilled	o Plywood or Veneer
o Meat, Fresh Frozen	o Structural Wood Products
o Meat Products	o Treated Wood Products
o Dressed Poultry, Fresh	o Misc. Wood Products
o Dressed Poultry, Frozen	o Pulp or Pulp Mill Products
o Processed Poultry or Eggs	o Fiber, Paper or Pulp board
o Creamery Butter	o Pressed or Molded Pulp Products
o Ice Cream or Frozen Desserts	o Paper or Building Board
o Cheese or Special Dairy Products	o Ashes
o Processed Milk	o Metal Scrap or Tailings
o Processed Fish	o Paper Waste or Scrap

After filtering the data by high weight jurisdiction O/Ds and commodity type, the dataset was used to distribute heavy truck trips on non-exemption portions of I-95 in Maine. A least travel time algorithm was applied to the data, and all truck flows were assigned to two sections of the Maine Interstate System: 1) the Maine Turnpike, and 2) non-exempt Maine Interstates.

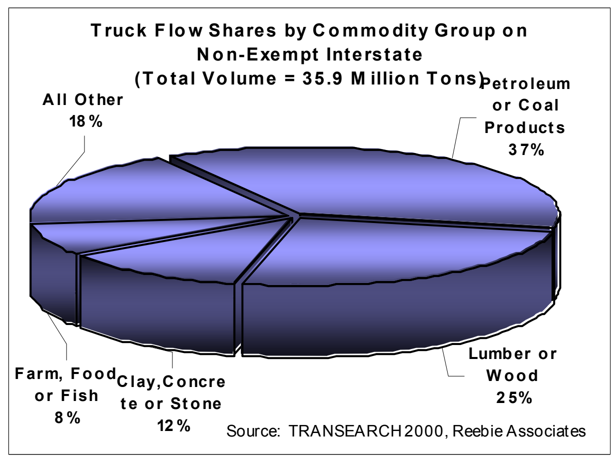
In developing the study scenario, the network assignment algorithm was used to load all truck flows to the Maine Interstate System, parallel routes were "turned-off." As a result, for any O/D pair requiring a north/south routing through Maine, I-95 and associated sections of Maine Interstates are treated as the only available routes.

Exhibit 6: Maine Turnpike Flows



The chart in **Exhibit 6** displays the relative weight shares by commodity groups for flow that were routed to the Maine Turnpike. The total volume of commodities routed to the Maine Turnpike from the TRANSEARCH database was 28.4 million tons.

Exhibit 7: Non-exempt Interstate Flows



The chart in **Exhibit 7** displays the relative weight shares by commodity group for flows routed to non-exemption portions of the Maine Interstate System. The total volume of flows routed from the TRANSEARCH database was 35.9 million tons. Combined routings to and from heavy weight jurisdictions by commodity group produced 1302 records for traffic assigned to the non-exempt Maine Interstate System. A final filter removed *most* intra-county movements. The filter is based on the expectation that most movements contained wholly within a single county would not be greatly impacted by a policy change the Interstate System. A summary of the TRANSEARCH tonnages applied to the *study network* are shown in **Exhibit 8.**

Exhibit 8: Summary of TRANSEARCH
(2002 Maine dataset only)

TRANSEARCH Scenario	Records	Total All Tons	Total all HWT Tons
All Maine traffic	96,400	87,355,609	21,860,386
W/O intra-county	96,295	81,818,116	17,425,592
Non-exempt Interstate	78,313	76,016,723	15,581,946

Exhibit 9 provides a sample of the STCC exempt-load commodity classifications used in the filtering and the associated tonnages for all flows to, from, and within Maine (the column "ALL tons"). And, the flow tonnages modeled as using or potentially using a route that includes non-exempt portions of the Interstate Highway System in Maine (the column "HWT tons on Maine I-95). Tonnages from a total of 48 commodity classes were used in the final modeling process.

Exhibit 9: Top Heavy Commodities and Tonnages

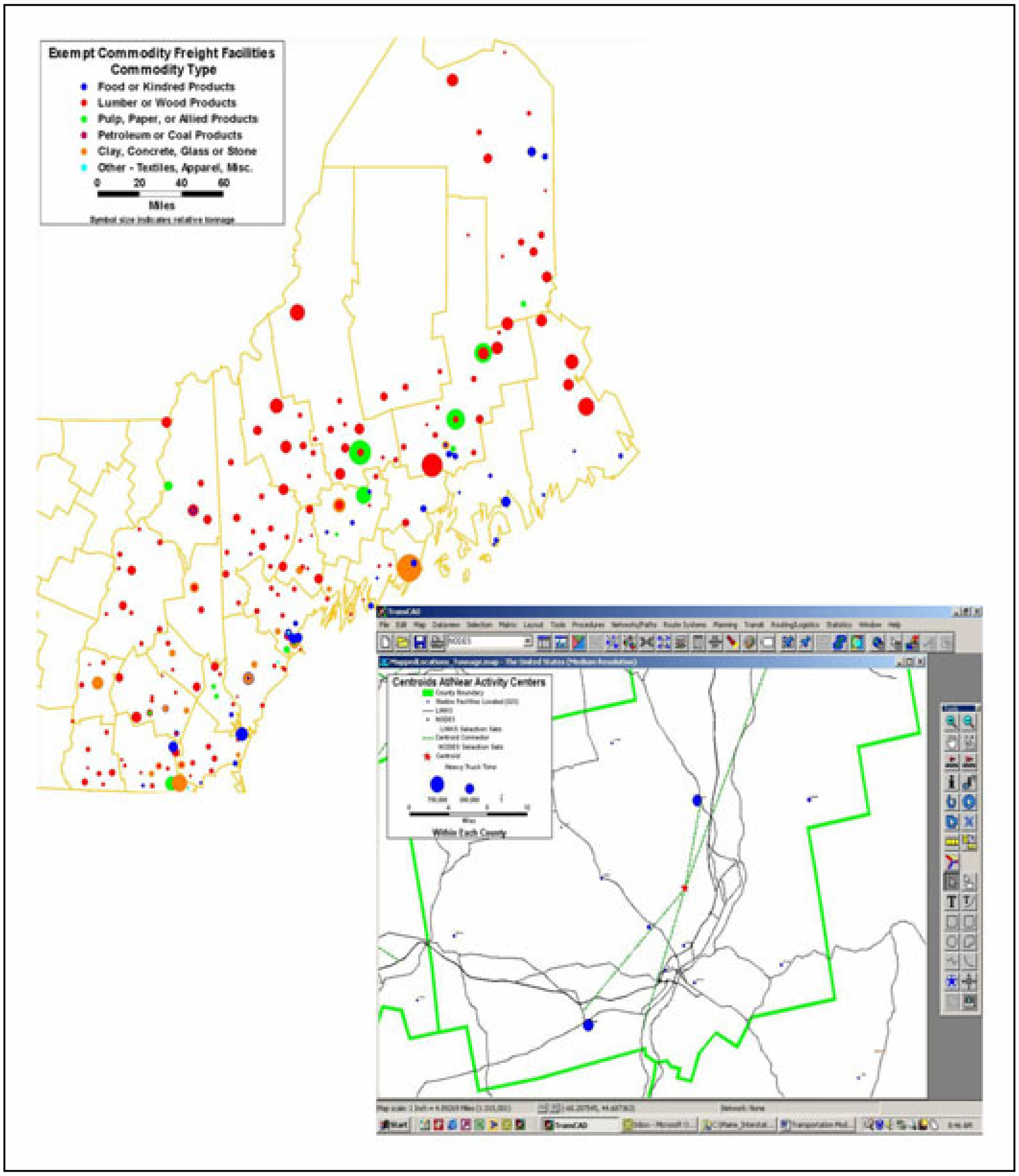
Standard Transportation Commodity Classification (STCC) 4-digit Level		ALL Maine flows		HWT flows on Maine I-95		
		ALL Lanes	ALL tons	HWT Lanes	HWT Tons	HWT Rank
2411	Primary Forest Materials	1175	15,390,074	415	5,501,511	1
3271	Concrete Products	668	1,127,162	338	830,851	2
2421	Lumber or Dimension Stock	2667	1,759,785	456	774,135	3
2611	Pulp or Pulp Mill Products	712	1,110,785	316	689,791	4
2026	Processed Milk	520	667,635	289	516,621	5
2661	Paper or Building Board	783	2,372,544	195	403,514	6
2499	Misc. Wood Products	2046	668,479	524	365,491	7
2097	Ice, Natural or Manufacture	354	308,251	187	233,310	8
2498	Wood Products	385	255,131	185	178,181	9
3241	Portland Cement	352	327,979	143	143,996	10

TRANSEARCH Freight Facility Information

An element of the commodity data purchased by the State of Maine included a data set containing the location of major industrial facilities. The *Freight Locator Database* included facilities in Maine that could be matched against the types of commodities they produce or receive. Facilities potentially receiving or producing products in exempt commodity groups were then identified.

The map in **Exhibit 10** illustrates facilities handling exempt weight commodities with an influence on traffic using the ME/NH Turnpike. The map markers for these facilities are scaled by their approximate annual truck freight tonnage for the exempt commodities. These facilities were added to the TransCAD model as freight generators. The facility locations were used to refine the freight flows in the analysis of the diversion network, where the county-level flows reported by TRANSEARCH do not provide sufficient detail (i.e. where there are many possible route options within the county). To assign traffic flows from one county to another, the counties (i.e. zones) were connected to the network. To replicate vehicle travel, "centroids" near county activity centers were assigned to each zone. The activity centers were based on the actual locations of these freight facilities, including intermodal facilities and other commodity depots identified in the Freight Locator data. **Exhibit 10** also shows the TransCAD screen used in linking centroids to the network.

Exhibit 10: Freight Facility Locations and Centroid Assignment



Converting Commodity Volumes to Truck Counts

Theoretically, with a GVW limit of 88,000 lbs. a fully loaded 5-axle TST can carry a payload of approximately 57,000 lbs. With a GVW of 100,000 lbs, a six-axle TST combination can carry a payload of approximately 68,000 lbs.[†] The payloads for 5 and 6-axle TST combination trucks

[†] A weighing sample of empty 6-axle TST vehicles by the Maine State Police found a wide range of tare weights. The theoretical tare weight used here is based on figures used in the USDOT Comprehensive Size and Weight

were applied to determine the theoretical 5 and 6-axle truck counts, and are shown in the table of **Exhibit 11.** These truck counts were later distributed across the study network in the modeling process.

**Exhibit 11: Truck Count Estimates:
Non-exempt Interstate Weigh-in-Motion (WIM) data**

Commodity Group	Total Truck Tons	Theoretical 5-Axle TST	Theoretical 5-Axle TST
Petroleum or Coal	13,135,524	460,896	386,339
Lumber, Wood & Paper	7,117,718	249,744	209,345
Food & Fish Products	1,087,548	38,160	31,987
Stone & Concrete Prod.	1,179,226	41,376	34,683
Total	**22,520,016**	**790,176**	**662,354**

Network development also entailed analyzing WIM data from Maine. Data was extracted from eight WIM stations in Maine that were used for network calibration. WIM stations record a variety of statistics for each vehicle passing over sensors imbedded in the pavement, including:

- Number of axles;
- Gross vehicle weight (GVW);
- A calculation of *equivalent standard axle load* (ESAL);
- Vehicle speed.

The WIM stations in Maine were installed early in 2001. Records for every vehicle with 5 or more axles were extracted, with the total number of records analyzed exceeding 8 million. Average annual daily values were then derived from the annual data sets. **Appendix A** presents detailed data summaries for each WIM station.

Observations from the WIM Data:

1. The detailed data indicate that significant proportions of the vehicles weighing over 80,000 GVW are 5 axle trucks.
2. Assessing the infrastructure or safety impacts resulting from illegally loaded (overweight) vehicles were beyond the scope of this study. However, the WIM data summaries suggest that vehicles in excess of legal limits account for a high proportion of the total ESAL loadings, and therefore pavement wear at some locations.
3. The direction and volumes of flows at specific points (the WIM stations) can only be interpolated to impacts at other points in the network by matching these flows to overall commodity flows and their ultimate origins and destinations.

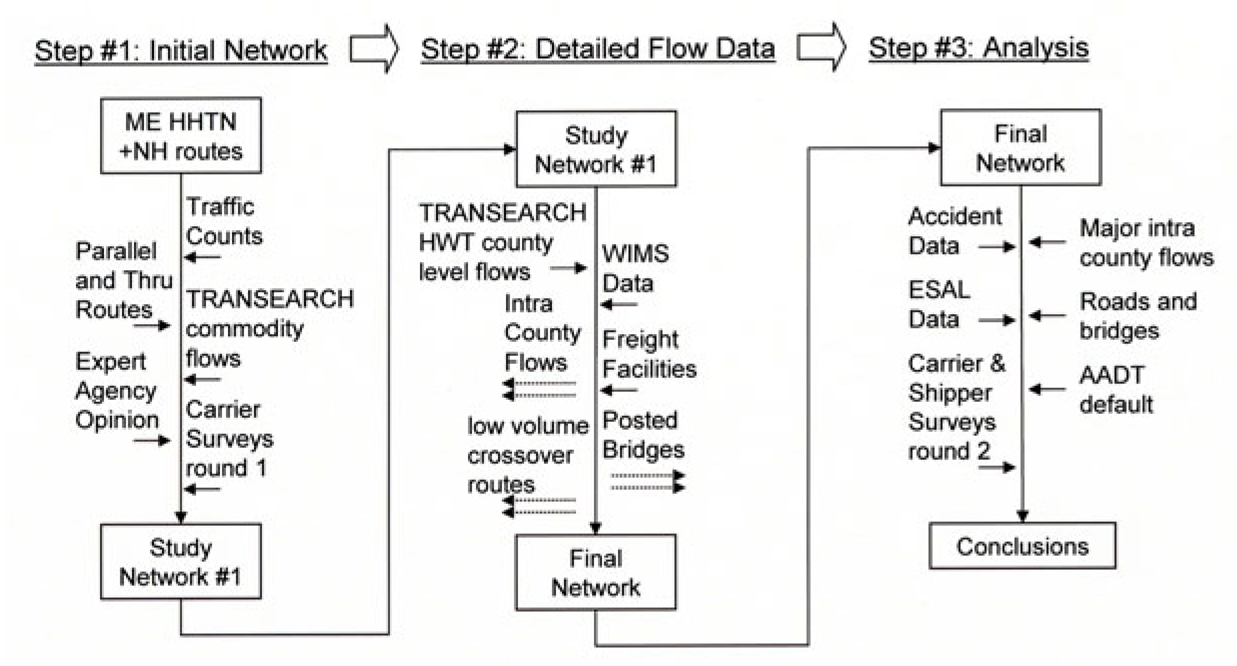
Study, and phone calls to semi-trailer manufacturers. The tare weights used also fell within the average empty vehicle weights for 5 and 6-axle trucks detected at Maine WIM stations.

Study Network Modeling Process

If the current Maine weight exemptions, in effect on State roads and the Maine Turnpike, were extended to the entire Maine Interstate System there would be an *increase* in 5 and 6 axle combination trucks, hauling loads between 80,000 and 100,000 lbs. GVW (exempt weights), on non-exempt elements of I-95. This would mean a *net decrease* in traffic on other routes. These other routes will be primarily State roads, but also the Maine Turnpike, particularly where it parallels I-95 between August and Portland.

The set of roads on which truck traffic is expected to change, as a result of the change in policy, is defined as the ***Study Network***. The study network was developed through truck count and commodity flow data, expert opinion, carrier interviews and a modeling process employing TransCAD software. The study network describes the roads on which traffic is expected to change as a result of allowing vehicles with a gross weight exceeding 80,000 lbs. on the non-exempt Maine Interstate System. Some roadways included in the study network serve primarily as connectors to I-95; these connector routes could see increases in traffic. The network was developed using the road geography from the TIDE database maintained by MDOT. All data were imported into a road network using TransCAD GIS modeling software. The modeling process allows specific groups of roadway links to be "enabled" or "disabled" and thus allowing the weight policy under consideration to be evaluated. The traffic flows being assigned to the network are derived from the TRANSEARCH tonnages previously discussed. These assignments were later calibrated against data from vehicle classification stations. The flow diagram in **Exhibit 12** shows the iterative process used in modeling and defining the *Study Network*.

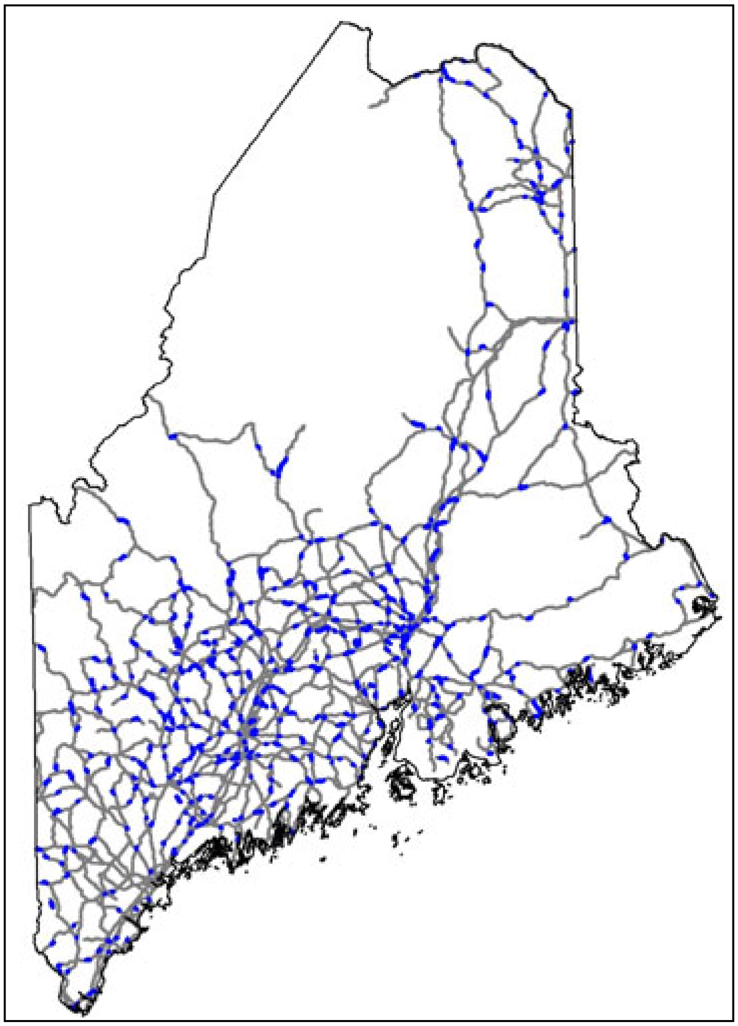
Exhibit 12: Flow Diagram of the Study Network Development Process‡



‡ Diagram Abbreviations: HHTN = Heavy Haul Truck Network, AADT = Average Annual Daily Traffic

Routing Assumptions

Exhibit 13: MDOT- Vehicle Classification Stations



The network assignment process started with three key routing assumptions. These assumptions were applied to a set of Maine roads defined by the Maine Heavy Haul Truck Network (HHTN).[2] The HHTN Study:

- Identified a network of Maine roadways where truck traffic is most intensive;
- Identified physical deficiencies along these roadways; and
- Determined the type and cost of improvements that best address these deficiencies.

The HHTN was developed using truck count data take from 842 vehicle classification stations maintained by MDOT (**Exhibit 13**). Since many of the same data sources were used in developing the *study network*, a brief description of HHTN process is provided as a starting point for discussing the development of the *study network*:

Assumption 1: Heavy Haul Truck Routes: The *study network* would be a subset of the Maine Heavy Haul Truck Network (HHTN). *Principal Arterials* were included in the HHTN by default, as were NHS *Intermodal Connectors*. Other facilities were included using the following criteria:

- A threshold ESAL value;
- System continuity and rationality.
- Input from the HHTN Study Committee, Regional Advisory Councils and Division Engineers;
- Connectivity with intermodal terminals, water ports, airports and major border crossings

Assumption 2: Parallel Routes: Truck drivers will choose the most time efficient route between origin and destination. As available routes change due to a change in regulatory policy, freight will switch to *the next most time efficient routes, which will broadly parallel the original routes*.

Assumption 3: Long-Distance Through Routes: The overall network must be able to carry through-traffic between distant points such as between New England States and Canada.

For the HHTN Study commercial vehicle counts were prorated across the entire Maine highway network wherever the truck percentage values were unknown. Unknown values were calculated by weighting the percent average annual daily traffic (AADT) for a given truck class from each of the classification station links, by the distance of the "unknown" link. For this study, the actual number of trucks in each class, (rather than percent) adjacent to unknown links was used as the prorate method to generate ESAL estimates. The modification reduces the potential for error when calculating urban ESALs.

The table in **Exhibit 14** shows the summary mileage of the road types in the study network. The TransCAD model used during this study stores road segments with much greater detail, including many short 'connectors' (on-ramps., etc.) that are not reflected in the summary

Exhibit 14: Study Network by Highway Class

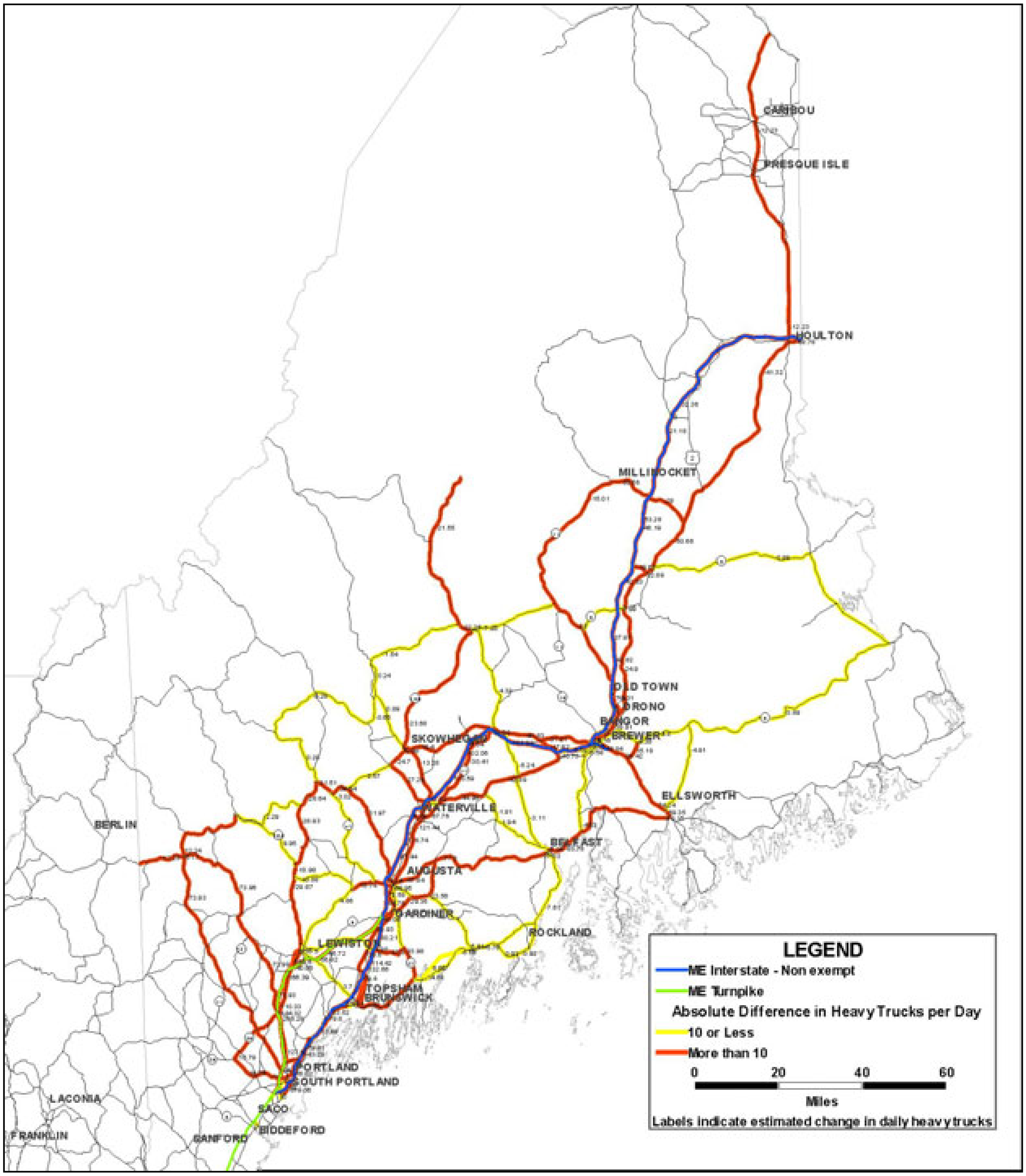
Functional Class	**Total Mileage**
Local and Other	18.5
Major Urban Collector	790.5
Minor Arterial	638.6
Minor Collector	16.5
Principal Arterial - Interstate	786.2
Principal Arterial - Other	807.1
Grand Total	**3,057.40**

Carrier Survey of O/D's and Primary Routes

As a reality check on the modeling process, a series of phone interviews were conducted with trucking companies to learn about their routing decisions. Details from the survey process are presented in **Appendix B.**

The map in **Exhibit 15** on the next page shows the network used in analyzing safety and infrastructure impacts.

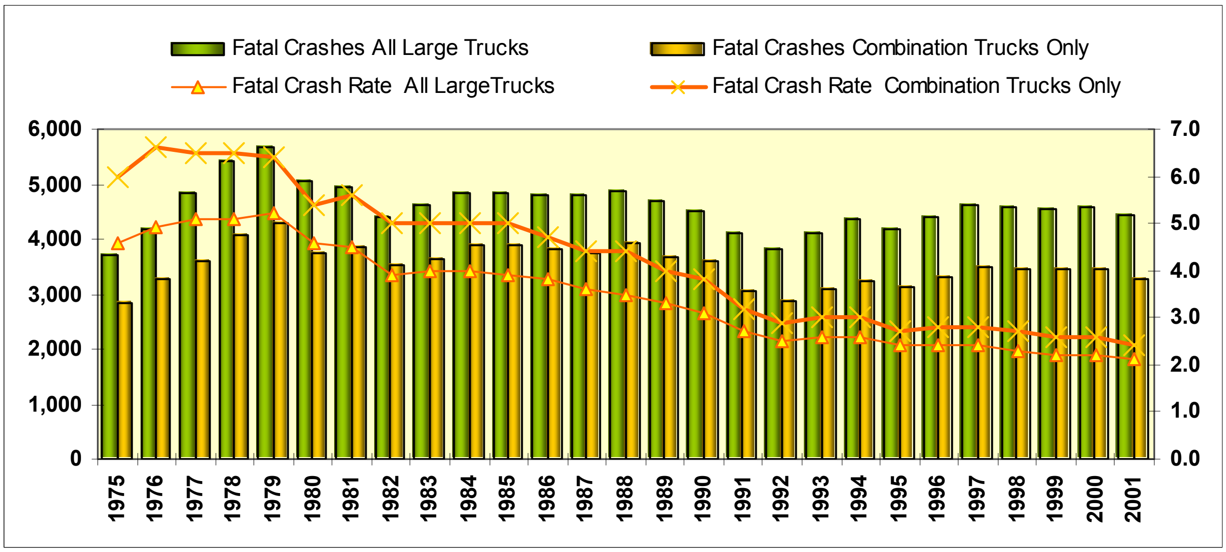
Exhibit 15: Final Study Network



Safety Analysis

Nationally, fatal crash involvements for all commercial vehicle types have held relatively steady over the past several years, but the rate of large trucks involved in a fatal crashes has shown a steady decline over two decades, declining 52% between 1981 and 2001. In 2000, large trucks (GVW rating greater than 10,000 lbs.) were involved in 456,930 traffic crashes in the United States. Of this total 4,573 were fatal crashes in which 5,282 people died.[3] In 2001, the number of fatal crashes and fatalities involving large trucks declined slightly to 4,431 and 5,082 respectively. In 2001, an additional 131,000 people were injured in crashes involving large trucks. Of all motor vehicle fatalities across the U.S. in 2001, fatalities from crashes involving a large truck represented 12 percent of the total.

Exhibit 16: National Fatal Crash Trends for Large Trucks



In **Exhibit 16,** the bar graphs show the trends in fatal crashes involving all large trucks and combination trucks over the past 25 years.[§] The line graphs depict fatal crash rates: crashes per 100 million vehicle miles of travel (VMT). Since 1981, large truck VMT has grown 91%, and as a result crash rates have shown a steady decline. The fatal crash rate for combination trucks has shown an even more dramatic decline, and in 2001 was roughly one-third what it was in 1976.

[§] Large trucks are defined as a truck with a gross vehicle weight rating (GVWR) greater than 10,000 lbs.. Combination trucks are defined as a truck tractor pulling any number of trailers (including none) or a straight truck pulling at least one trailer.

Geo-coded Truck Crash Analysis on the Maine Portion of the Study Network

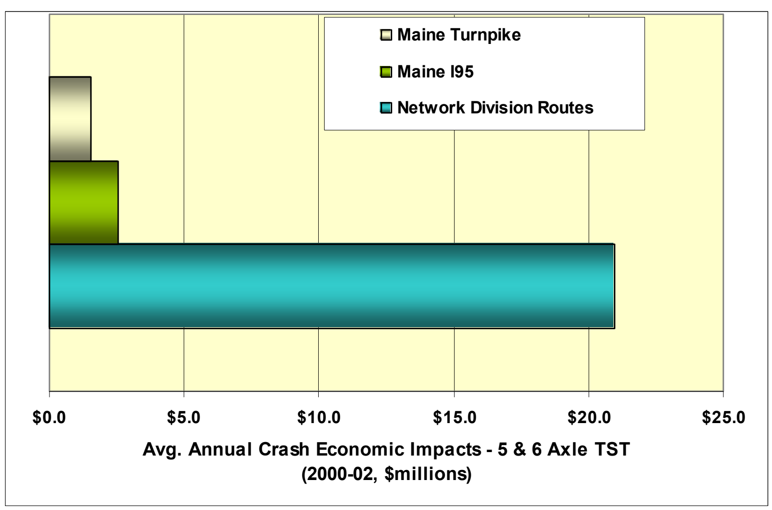
Geo-coded crash data was available from the MDOT that allow TST crash rates to be analyzed by road type. A previous study of truck size and weight noted a strong correlation between crash rates and functional highway class:

> *"Numerous analyses of crash data bases have noted that truck travel, as well as all vehicle travel, on lower standard roads (that is, undivided, higher speed limit roads with many intersections and entrances) significantly increases crash risks compared to travel on Interstate and other high quality roadways. The majority of fatal crashes involving trucks occur on highways with lower standards…. The [fatal crash] involvement rate on rural Interstate highways is 300 percent to 400 percent lower than it is on other rural roadway types and is generally the same for all vehicle types."*[4]

The purpose of this analysis was to compare TST crash rates on controlled access Interstate-level facilities to other roadway types in the diversion network. The geo-coded crash analysis divides the 14,244 road segments of the study network into 3 groups of roadway facilities (note that *each study network segment is in one, and only one, group*):

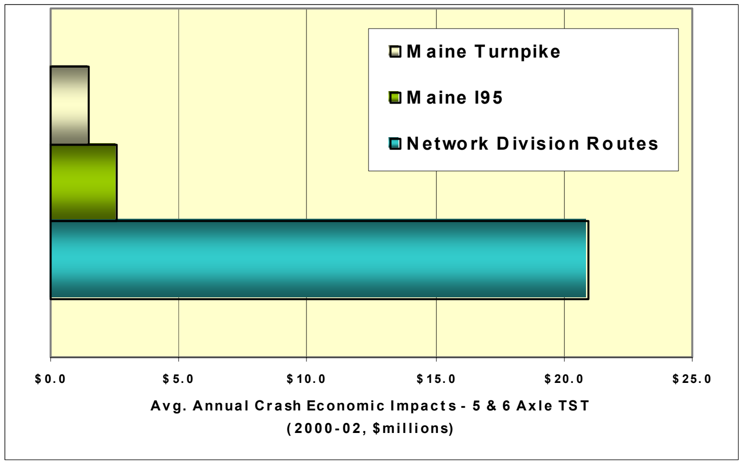
- **Non-Exempt Interstates**, controlled-access facilities expected to gain traffic in the study scenario (interstate exempt). Maine non-exempt Interstate roads consisted of 546 centerline miles (of two or more lanes, running in the same traffic direction).
- **Maine Turnpike**, controlled-access facilities expected to lose traffic in the study scenario. The Maine Turnpike roads consisted of 242 centerline miles.
- **Diversion Routes**, which constitute the rest of the *study network*, and which are expected to lose traffic, on net, in the scenario under study. "Diversion" routes consisted of 4,538 centerline miles (primarily of two lanes, each running in opposite traffic directions).

Exhibit 17: Annual Network TST Crashes



1. **Develop crash records with matching route and vehicle criteria:** Three years of geo-coded crash data were filtered by recorded vehicle type to extract only crashes involving 5 or 6-axle TST vehicles, with GVW registrations of 80,000 lbs. or more. Only crashes occurring on some portion of the *study network* were extracted. A total of 1,219 crashes from the three years of data passed both filters to constitute the crash sample. **Exhibit 17** shows the annualized number of 5 and 6-axle TST crashes on the Maine Turnpike, non-exempt Interstate, and *study network* "diversion" routes.

Exhibit 18: Annual Economic Impacts – TST Crashes



An FHWA derived "economic impact" figure associated with crash severity was also included in the MDOT crash records.[**] The calculated economic impacts were based on standard values using the number of damaged vehicles and personal injury or death. The total calculated economic impact from all 1,219 crashes was $75,032,000. The annualized economic impact attributed to the three roadway sets is show in **Exhibit 18.**

2. **Derivation of *Study Network* VMT:** Road segments in the *study network* contain estimates of 5 and 6 axle TST-AADT for many *but not all* segments. For each segment with known TST-AADT: TST counts were multiplied by length of the segment; summed; and, divided by the total of all known AADT segment lengths, to produce an average TST-AADT. The averages for known-AADT segments were 2,226 AADT for the Maine Turnpike, and 151 AADT on "diversion" roadways. The average TST-AADT counts from known segments were then multiplied by total miles (including segments with *unknown* TST AADT) to produce "*length adjusted VMT*". These steps resulted in annual VMT (expressed in 100-million miles) of 1.73 on the "Maine Turnpike, and 2.51 on the "diversion" roadways.

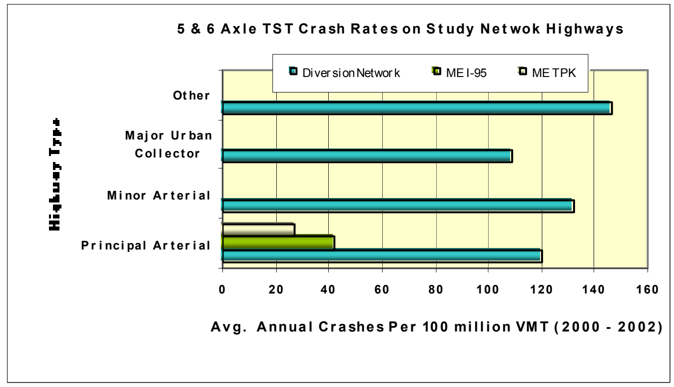
   The procedure used in deriving VMT estimates for diversion routes of the study is expected to result in *overestimated* VMT, as missing AADT counts on secondary routes are likely to be on those segments with low traffic. To some extent the opposite affect is expected on interstate level facilities: i.e., missing AADT counts on controlled-access roads are typically segments with multiple entry and exit points, such as urban areas, which often experience higher traffic levels. To the extent that this occurs, Interstate AADT may *underestimate* traffic on controlled access roads. To correct for this tendency an *attenuation procedure* was applied. For the controlled access road set, only 75% of the VMT increase (from "known" to "length-adjusted" VMT) was actually included in the final "length adjusted" VMT.

   The *net effect* of the two procedures is expected to result in crash rates relatively more conservative toward diversion routes, than would be expected if actual VMT were known for every road segment. Since the diversion roads are generally expected to have the higher crash rates, the effect is considered a conservative approach when comparing the crash rates: the error will be towards indicating smaller crash rate differences (between controlled access roads and other road types), rather than larger.

[**] USDOT, FHWA Technical Advisory T7570.2 Motor Vehicle Accident Costs, October 31, 1994.

3. **Exhibit 19** shows the crash rates for 5 and 6 axle TST combination vehicles on the Maine Turnpike and on all other study network routes.[††] Of particular note is the low crash rate of the Maine Turnpike which currently allows vehicles over 80,000 lbs.

Exhibit 19: *Study Network* TST Crash Rates



4. **Forecast net change in crashes:** As noted in the network development discussion, estimates of ton-mile flows for exempt commodities were distributed to the *study network*, using commodity volume data and the flows were converted to truck vehicle miles. The forecasted changes in VMT under the study condition were multiplied by the overall crash rates and associated economic impacts derived in the crash analysis to estimate the annual change in number of crashes and associated economic impacts.

Geo-code Crash Analysis Results: The three step analysis allowed the study team to produce comparative crash statistics for each functional highway class in the study network Graphics examining some of the factors associated with TST crashes in Maine such as: Crash type, and injury levels are shown and briefly discussed on this and the next page.

Exhibit 20: TST Crash Rates by Highway Type

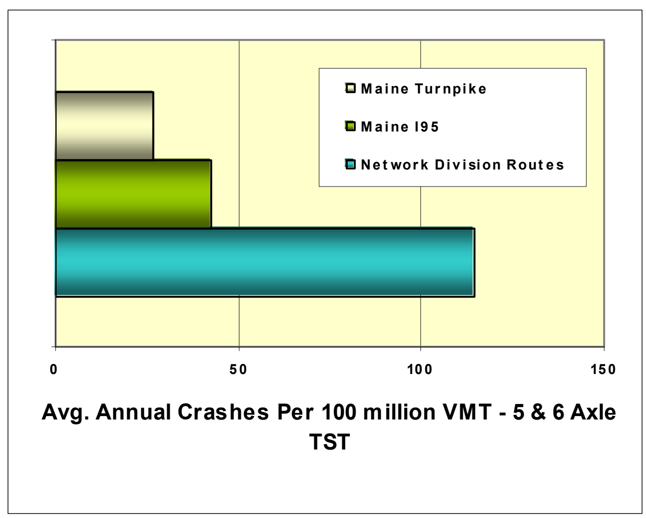


Exhibit 20 shows the crash rates derived for 5 and 6-axle TST combinations the study network by functional highway class. The crash rate per 100-million VMT (HMVMT), for the Maine Turnpike is 27 crashes/HMVMT, and is the lowest of all for all highway classes examined by the analysis. The crash rate for non-exempt portions of the Maine Interstate was 42 crashes/HMVMT. All other highway types in the study network, including other principal arterials are at least 4 times higher

[††]Crash counts and rates are based upon "vehicle involvement" where each truck was counted as one "involvement". Thus a single crash involving two trucks would count as "two involvements" for the reported crash counts and rates. Crashes involving multiple trucks were approximately 1% of the total.

than the crash rate on the Turnpike, and more than double the rate for the non-exempt Interstate System.

Exhibit 21: Study Network Crash Rates by Crash Type

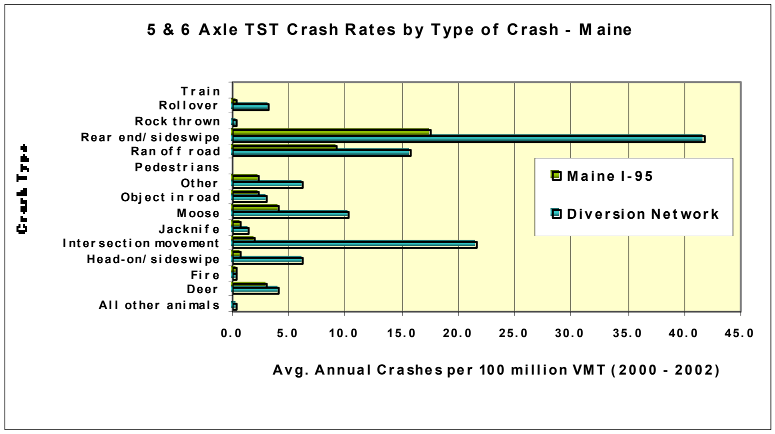


Exhibit 21 displays the crash rates for 5 and 6-axle TST involvements, by type of crash, for non-exempt Maine Interstate Highways and all other functional highway classes in the diversion road set. While diversion route crash rates are higher for all crash types, *intersection movement*, *head-on sideswipe*, and *read-end sideswipe* are all dramatically more prominent. *Rear-end sideswipe* crashes exhibit the highest crash by type rate for TST vehicles on non-exempt Interstate facilities with a rate of 18 crashes/ HMVMT. Nonetheless, the crash rate for *rear-end sideswipe* for non-interstate facilities is more than double; 42 crashes/HMVMT.

Exhibit 22: Study Network Crash Rate by Severity

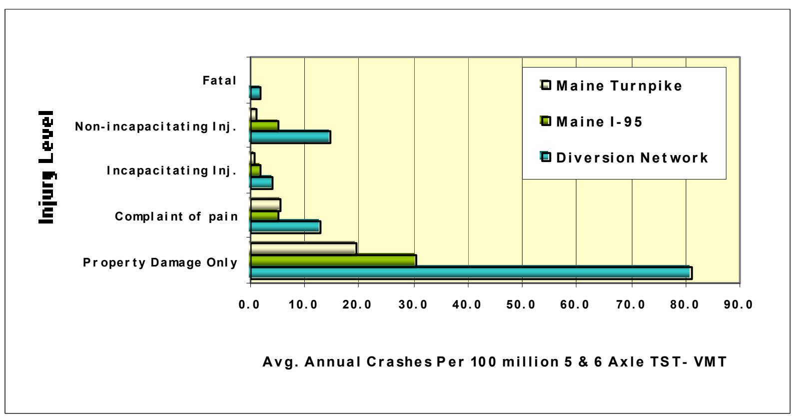
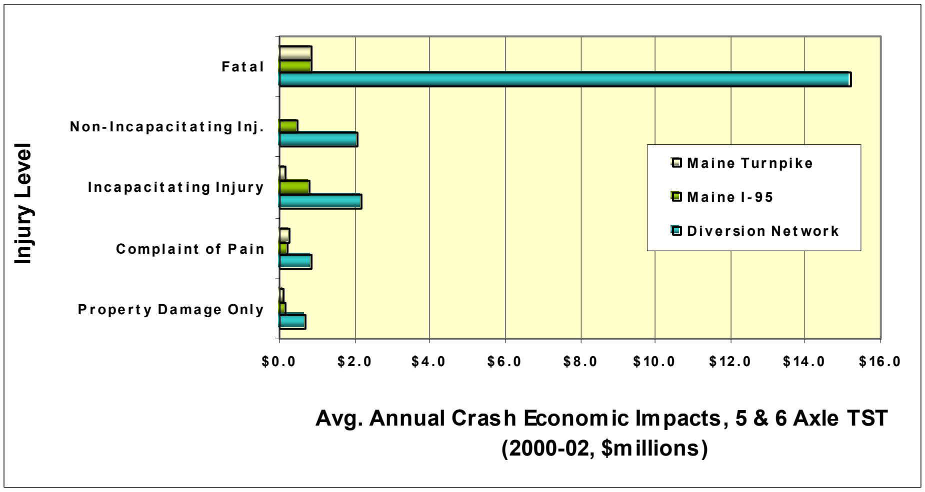


Exhibit 22 displays crash rates for the Maine Turnpike, non-exempt Interstate Highways and other functional highway classes combined for the study network by severity of the crash.

The fatal crash rate of 0.2 crashes/ HMVMT for both the Maine Turnpike and non-exempt portions of the Maine Interstate is not visible on the graphic. The fatal crash rate of 1.9 crashes/HMVMT on diversion routes is nearly 10 times the fatal crash rate on Interstate facilities. Incapacitating injury crashes are nearly 7 times more prevalent on diversion roadways than on the Turnpike portions of I-95 and more than twice as prevalent as on non-exempt portions of Maine's Interstate Highways.

Exhibit 23 shows the economic costs associated with injury severity for the Maine Turnpike, non-exempt Interstate and the combination of all other highway types (diversion road set) of the study network.

Exhibit 23: Annual Economic Impacts for Crashes by Severity



Fatal crashes involving 5 and 6 axle TST combinations on non-Interstate facilities in the study network are estimated to carry an associated annual economic impact of $15 million per year. The associated economic impact on all Maine Interstate facilities (Turnpike and non-exempt combined) for TST fatal crashes is $1.8 million per year.

When modeling the impact of extending the current weight exemption on the Turnpike to all non-exempt Maine Interstate Highways, it was estimated that non-exempt Interstate Highways would experience an increase of 3.8 crashes per year, but the loss of traffic from other roadways in the study network would result in 0.7 fewer crashes per year on the Maine Turnpike, and 6.3 fewer crashes on non-Interstate facilities.

The safety analysis indicates that if Congress were to extend the current weight exemption on the Maine Turnpike to all currently non-exempt Interstate Highways in Maine, the net impact to Maine would be a <u>decrease</u> of 3.2 crashes annually. The associated FHWA defined economic impacts would save $356,000 per year.

Comparative Analysis of Truck Crashes by State

In addition to geo-coded analysis of TST vehicle crashes in Maine, the study team also examined fatal truck crashes across all states to gain an understanding of the relative safety environment for commercial vehicles in Maine as compared to other jurisdictions.

The study team used records from the University of Michigan Transportation Research Institute (UMTRI), "*Trucks Involved in Fatal Accidents*" (TIFA) files. Fatal semi-truck crashes were extracted for a 5 year period (1996 – 2000). Using only fatal crashes held an advantage of having a higher degree of consistency in reporting across states and years. **Exhibit 24** contains the table of state comparison statistics. Between 1996 and 2000, Maine averaged 11 fatal truck crashes per year.

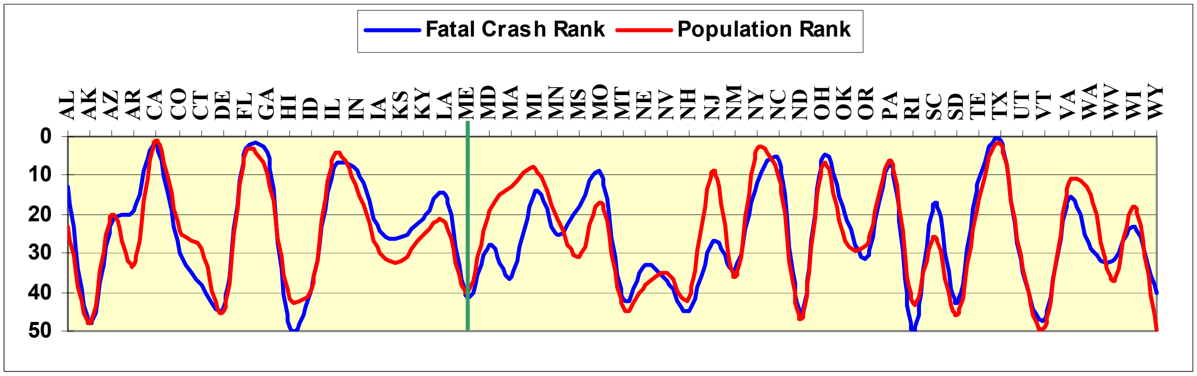
While population is far from a perfect predictor of commercial vehicle traffic, 7 of the 10 most populous states also averaged the most TST crashes (New York, Michigan and New Jersey were exceptions). The 10 least populous states also recorded the fewest fatal semi-truck crashes. Maine, 40th in state population, ranked 42 in fatal semi-truck crashes, and 43rd in truck ton-miles.

Exhibit 25 (next page) plots the rank of state population against the state rank for average annual fatal semi-truck crashes. The resulting histogram demonstrates that with a few exceptions, population shows a high correlation with total fatal semi-truck crashes.

Exhibit 24: Comparison of Fatal TST Crashes

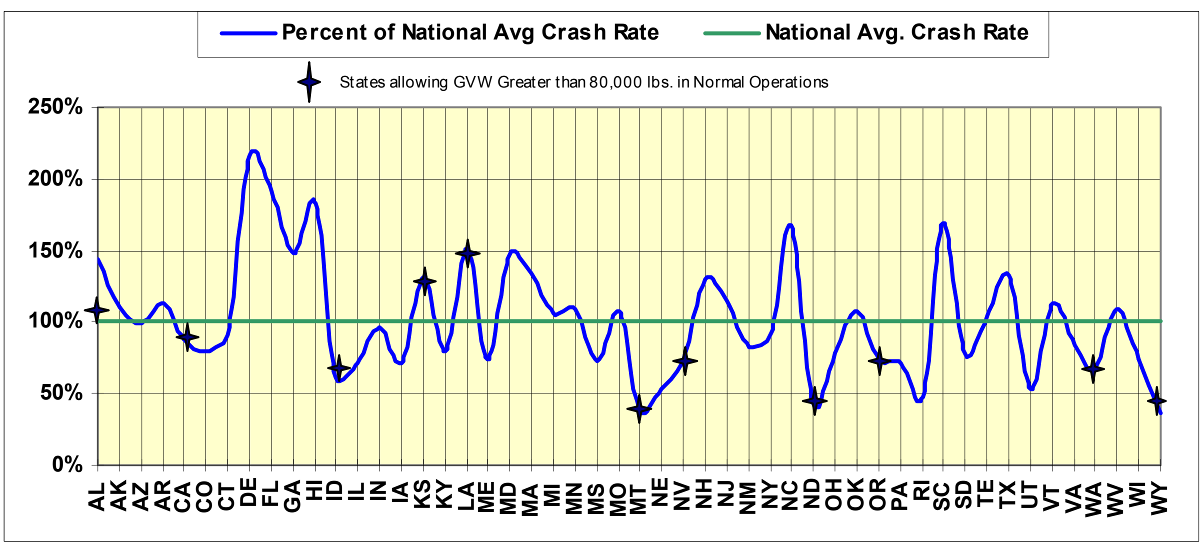
Total Fatal Truck Crashes (1996-2000)		5-yr Annual Avg. Fatal Truck	Rank	2000 Census Population	Pop. Rank
AL	534	107	10	4,447,100	23
AK	12	2	48	626,932	48
AZ	305	61	21	5,130,632	20
AR	387	77	16	2,673,400	33
CA	873	175	3	33,871,648	1
CO	192	38	28	4,301,261	24
CT	72	14	40	3,405,565	29
DE	55	11	44	783,600	45
FL	884	177	2	15,982,378	4
GA	684	137	4	8,186,453	10
HI	7	1	49	1,211,537	42
ID	73	15	39	1,293,953	39
IL	602	120	7	12,419,293	5
IN	596	119	8	6,080,485	14
IA	306	61	20	2,926,324	30
KS	279	56	24	2,688,418	32
KY	286	57	22	4,041,769	25
LA	407	81	13	4,468,976	22
ME	56	11	42	1,274,923	40
MD	206	41	26	5,296,486	19
MA	109	22	36	6,349,097	13
MI	400	80	14	9,938,444	8
MN	282	56	23	4,919,479	21
MS	164	33	32	2,844,658	31
MO	511	102	11	5,595,211	17
MT	61	12	41	902,195	44
NE	183	37	30	1,711,263	38
NV	99	20	37	1,998,257	35
NH	43	9	46	1,235,786	41
NJ	197	39	27	8,414,350	9
NM	188	38	29	1,819,046	36
NY	350	70	17	18,976,457	3
NC	636	127	6	8,049,313	11
ND	44	9	45	642,200	47
OH	666	133	5	11,353,140	7
OK	348	70	18	3,450,654	27
OR	178	36	31	3,421,399	28
PA	537	107	9	12,281,054	6
RI	4	1	50	1,048,319	43
SC	389	78	15	4,012,012	26
SD	56	11	43	754,844	46
TE	508	102	12	5,689,283	16
TX	1462	292	1	20,851,820	2
UT	119	24	35	2,233,169	34
VT	27	5	47	608,827	49
VA	348	70	19	7,078,515	12
WA	142	28	34	5,894,121	15
WV	159	32	33	1,808,344	37
WI	271	54	25	5,363,675	18
WY	78	16	38	493,782	50

Exhibit 25: Annual Fatal Truck Crash Rank Vs. State Population Rank



The ability to relate crashes to traffic exposure is often a difficult goal at a sub-national level. The most common "crash rate" is expressed as crashes per 100 million VMT. However, other measures of exposure can be used, such as crashes per number of licensed drivers, or crashes per ton-mile. A "Fatal Semi-Truck Crash Rate" was computed using the TIFA 5 year average and ton-mile estimates by state from the 1997 BTS Commodity Flow Survey (CFS). **Exhibit 26** plots the result for each state as a percentage against the national average (equal to 100%). Also highlighted on this graph are eleven states allowing gross vehicle weights in excess of 80,000 lbs. in regular operations on state highway systems.‡‡ Among the states allowing heavier GVW in regular operation only three have crash rates above the national average. Three "heavy truck" states had crash rates less than 50% of the national average. The remaining 5 heavy truck states are below the average.

Exhibit 26: Fatal TST Crashes Per Billion Ton-miles (Shown as % of National Average)



‡‡ Source: J.J. Keller – Vehicle Sizes and Weights, Maximum Limits table, January 1, 2003. (Note: some states, including Maine only allow GVW's exceeding 80,000 lbs. under special circumstances; and are not included here).

Regression Analysis of Tractor-Semi-trailer (TST) Crashes

The study team also conducted a regression analysis to examine the correlations between TST crashes, cargo volume and truck VMT. An additional variable was introduced for the regression analysis: tractor-semi-trailer vehicle miles of travel (TST-VMT) by state. Highway Performance Monitoring System (HPMS) base data from FHWA containing VMT by functional class and vehicle type was used for the analysis. For each state, the 5 year average of fatal crashes involving TST combinations was regressed against year 2000 TST-VMT and year 1997 truck freight ton-miles. **Exhibit 27** presents the strongest relationships found from the regression analysis using these variables.

Exhibit 27: Regression on TST Annual Fatal Involvements (TST-FI)

(R-square = 0.906)	Coefficients	Std Error	t-Stat	P-value
Intercept	35.2	7.64	4.603	0
a) TST-VMT (100 million)	32.8	2.51	13.079	0
b) ratio of truck ton-miles to all truck VMT	-43.6	8.53	-5.116	0
c) ratio of urban TST-VMT to all TST-VMT	-24.4	13.73	-1.778	0.082
d) normal GVW limit over 80,000 lbs	-7.4	6.64	-1.116	0.271

The most significant findings indicate:

- Row a) Results suggest a strong, positive relationship between TST-VMT and fatal TST crashes, indicating that fatal TST crashes are expected to increase as TST-VMT increases. This correlation holds across all states with greater than 99% confidence.
- Row b) Results show a strong negative relationship between the ratio of truck ton-miles to TST-VMT, and the number of fatal TST crashes, suggesting that fatal TST crashes are expected to decrease as average payload increases. The correlation holds across all states with greater than 99% confidence. This finding supports previous studies suggesting that higher payloads will likely reduce crashes, presumably by reducing TST-VMT.

Regression Results for Maine

- Maine exhibited crash rates below the average by both VMT and ton-mile measures. A strong explanatory factor is Maine's ratio of ton-mile/truck VMT (6.039) is higher (106.61%) than the national average – in other words, Maine has higher than average truck payloads and based on the correlations found in the data, is expected to have a lower than average TST fatal crash rate.

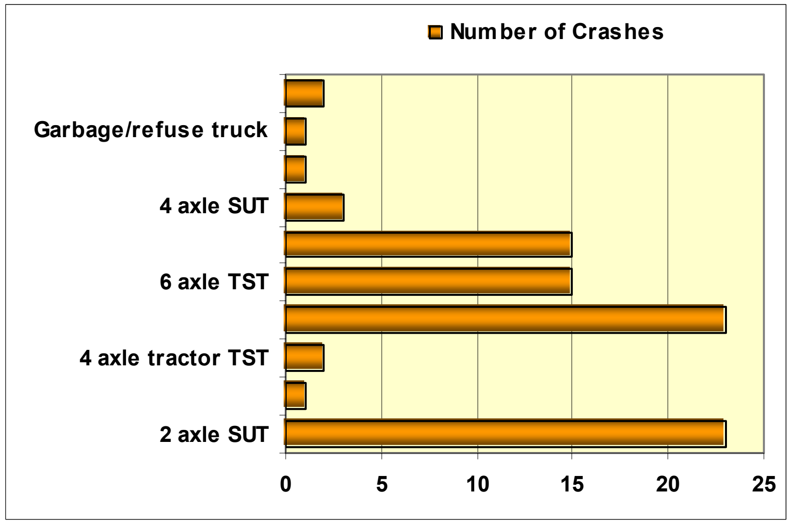
Exhibit 28, on the next page shows the resulting state and national "semi-truck fatal crash rates" using both VMT and ton-miles as denominators.

Exhibit 28: Annual TST Fatal Involvements, Freight Ton-miles, and VMT

State * = GVW over 80,000 lbs. (d)	TST Fatal Crashes 5-yr. Avg	Total Truck Ton-Mi (billions)	TST-fatal crash rate per billion ton-miles	% of Natinal Average	a) TST-VMT (x 100 million)	TST - Fatal Crash Rate per 100 million VMT	% of National Average	b) Ratio of Ton mi./VMT for All Trucks	% of National Average	c) Ratio of Urban Road/ All Road TST-VMT
Alabama	107	28.1	3.8	144.1%	3,143	3.4	146%	5.59	99%	34.0%
Alaska *	2	0.8	2.9	110.9%	59	4.1	175%	3.76	66%	36.3%
Arizona	61	23.4	2.6	98.8%	3,356	1.8	78%	4.84	86%	36.8%
Arkansas	77	25.9	3.0	113.1%	2,332	3.3	142%	8.30	147%	13.6%
California	175	75.4	2.3	87.7%	9,733	1.8	77%	4.65	82%	61.6%
Colorado *	38	18.2	2.1	80.1%	1,453	2.6	113%	6.46	114%	22.4%
Connecticut	14	6.0	2.4	91.4%	876	1.6	71%	4.38	77%	68.9%
Delaware	11	1.9	5.7	217.0%	280	3.9	169%	3.88	68%	50.7%
Florida	177	34.9	5.1	192.0%	5,069	3.5	150%	3.80	67%	50.0%
Georgia	137	35.1	3.9	147.6%	5,135	2.7	114%	4.55	80%	21.1%
Hawaii	1	0.3	4.8	182.9%	50	2.8	120%	0.95	17%	66.5%
Idaho *	15	9.1	1.6	61.0%	665	2.2	94%	8.81	156%	20.1%
Illinois	120	63.7	1.9	71.6%	7,943	1.5	65%	6.18	109%	56.1%
Indiana	119	47.1	2.5	95.9%	5,882	2.0	87%	5.65	100%	38.0%
Iowa	61	32.7	1.9	70.9%	2,973	2.1	88%	8.33	147%	14.4%
Kansas *	56	16.0	3.5	131.9%	1,390	4.0	172%	6.99	123%	13.7%
Kentucky	57	27.1	2.1	80.1%	2,357	2.4	104%	7.80	138%	22.9%
Louisiana	81	20.4	4.0	151.5%	2,558	3.2	137%	4.88	86%	33.1%
Maine	**11**	**5.7**	**2.0**	**74.7%**	**532**	**2.1**	**90%**	**6.04**	**107%**	**13.7%**
Maryland	41	10.6	3.9	146.8%	949	4.3	186%	4.43	78%	63.0%
Massachusetts	22	6.2	3.5	133.8%	1,082	2.0	86%	2.95	52%	77.8%
Michigan *	80	28.5	2.8	106.5%	3,699	2.2	93%	4.89	86%	55.0%
Minnesota	56	19.6	2.9	109.1%	1,751	3.2	138%	5.73	101%	23.9%
Mississippi	33	17.1	1.9	72.8%	2,594	1.3	54%	4.38	77%	19.2%
Missouri	102	35.8	2.9	108.2%	3,683	2.8	119%	6.43	114%	25.3%
Montana *	12	11.9	1.0	38.7%	539	2.3	97%	14.49	256%	10.9%
Nebraska	37	26.1	1.4	53.2%	1,737	2.1	90%	12.36	218%	10.1%
Nevada *	20	10.2	1.9	73.3%	780	2.5	109%	7.95	140%	25.4%
New Hampshir	**9**	**2.5**	**3.4**	**129.3%**	**252**	**3.4**	**146%**	**4.65**	**82%**	**27.9%**
New Jersey	39	13.0	3.0	115.1%	2,188	1.8	77%	3.60	64%	79.0%
New Mexico	38	17.4	2.2	82.0%	1,429	2.6	113%	7.79	138%	11.8%
New York	70	28.9	2.4	91.8%	4,503	1.6	67%	3.92	69%	48.3%
North Carolina	127	28.7	4.4	168.1%	4,850	2.6	113%	3.45	61%	34.5%
North Dakota *	9	7.7	1.1	43.2%	459	1.9	82%	10.09	178%	10.0%
Ohio	133	64.5	2.1	78.2%	8,194	1.6	70%	5.70	101%	44.4%
Oklahoma	70	24.5	2.8	107.5%	3,412	2.0	88%	4.96	88%	17.9%
Oregon *	36	18.1	2.0	74.5%	2,185	1.6	70%	5.69	101%	24.4%
Pennsylvania	107	56.9	1.9	71.5%	4,692	2.3	98%	7.31	129%	34.5%
Rhode Island	1	0.6	1.3	48.1%	153	0.5	22%	2.37	42%	76.4%
South Carolina	78	17.4	4.5	169.0%	2,190	3.6	152%	5.15	91%	20.1%
South Dakota	11	5.4	2.1	78.0%	519	2.2	93%	6.88	122%	10.5%
Tennessee	102	37.2	2.7	103.5%	3,898	2.6	112%	6.81	120%	33.3%
Texas	292	83.5	3.5	132.7%	10,065	2.9	125%	5.15	91%	37.8%
Utah	24	16.8	1.4	53.7%	930	2.6	110%	11.17	197%	34.5%
Vermont	5	1.8	3.0	113.6%	260	2.1	89%	4.10	72%	20.9%
Virginia	70	31.7	2.2	83.3%	3,286	2.1	91%	6.58	116%	29.1%
Washington *	28	16.1	1.8	66.9%	1,306	2.2	93%	5.80	102%	50.7%
West Virginia	32	11.1	2.9	108.3%	1,271	2.5	107%	6.18	109%	25.6%
Wisconsin	54	27.9	1.9	73.6%	2,479	2.2	94%	7.02	124%	29.2%
Wyoming *	16	16.1	1.0	36.8%	901	1.7	74%	14.38	254%	6.4%
National (total)	**3076**	**1165.3**	**2.6**	**100.0%**	**132,022**	**2.3**		**5.66**		**37.2%**

Fatal Truck Crashes in Maine

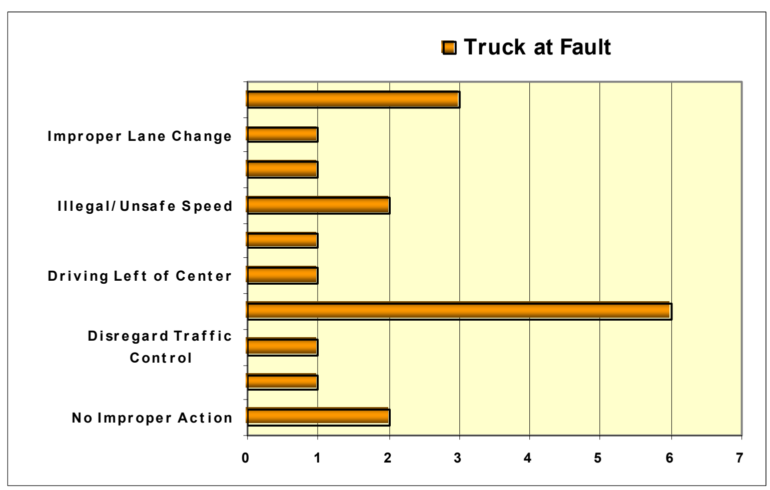
Exhibit 29: Fatal Truck Crashes by Vehicle Type (1999-01)



The State of Maine also provided three years of fatal truck crash reports (1999-2001). The crash reports indicated 78 fatal truck crashes in Maine over the three year period, 74 were multiple vehicle crashes, with 16 crashes involving more than two vehicles. **Exhibit 29** displays fatal truck crashes for Maine by vehicle type for the years 1999 – 2001. The data shows that in Maine single unit trucks (SUT) and TST combinations were nearly equally involved in fatal crashes over the period. 2-axle single unit trucks (SUT) and 5-axle TST combinations where the vehicles types most often involved in a fatal crash, each experiencing 23 crashes.

More than 80% of the fatal crashes occurred during daytime the hours of 6:00 am to 6:00 pm. Of the crashes that occurred during night-time hours, 12 occurred on unlit roadways. Only seven fatal truck crashes over the period occurred on Saturday or Sunday. The weekday distribution of fatal crashes was fairly evenly distributed between 12 and 16.

Exhibit 30: Contributing Factors for "Truck at Fault"



A review of the fatal crash reports was conducted to determine those crashes were the truck driver was found to be at fault. The bar chart in **Exhibit 30** summarizes the contributing factors from fatal truck crashes in Maine from 1999-2001, where the truck driver was determined to be at fault. The most prominent contributing factor was found to be driver inattention or distraction.

Exhibit 31: Fatal Truck Crashes by Type (1999-2001)

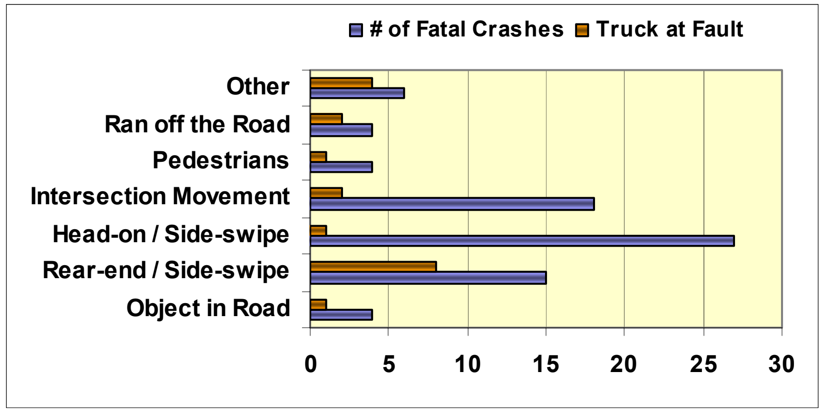


Exhibit 31 presents a histogram of crashes by the type of incident that resulted in a fatality. The most prominent fatal crashes involving commercial vehicles were: head-on/sideswipe, rear end/sideswipe and intersection movement collisions. The line graph on the chart indicates the number of these crashes that were attributed to the truck driver based on a review of crash records. Of the most prominent crash type; "head-on / side-swipe" only one crash was attributed to the commercial vehicle driver. In "truck driver-at-fault crashes, the most prominent contributing factor was driver inattention or distraction (6 fatal crashes), followed by illegal or unsafe speed (2 fatal crashes).

Exhibit 32 presents data from fatal truck crashed in Maine between 1999 and 2001 about the truck drivers' age. Truck drivers between the ages of 31 and 35, were the driver group most likely to be involved in a fatal crash. Drivers age 36 to 40 were the next most represented group, followed by drivers age 41 to 45. These three driver age groups, representing drivers age 31 to 45 were involved in 50% of all fatal crashes during the time period. As in the previous chart, the line graph represents the number of drivers by age group determined to be at fault.

Exhibit 32: Fatal Truck Crashes in Maine by Driver Age, 1999-2001

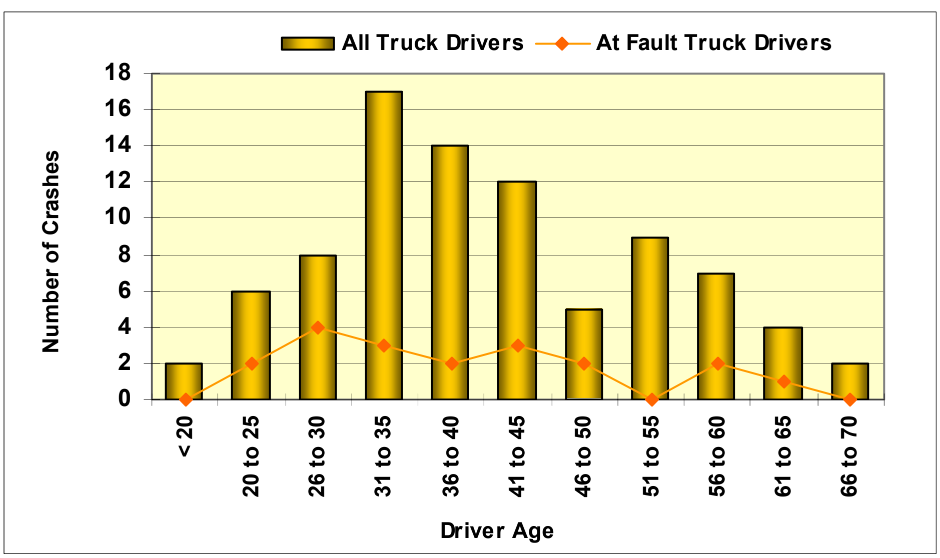
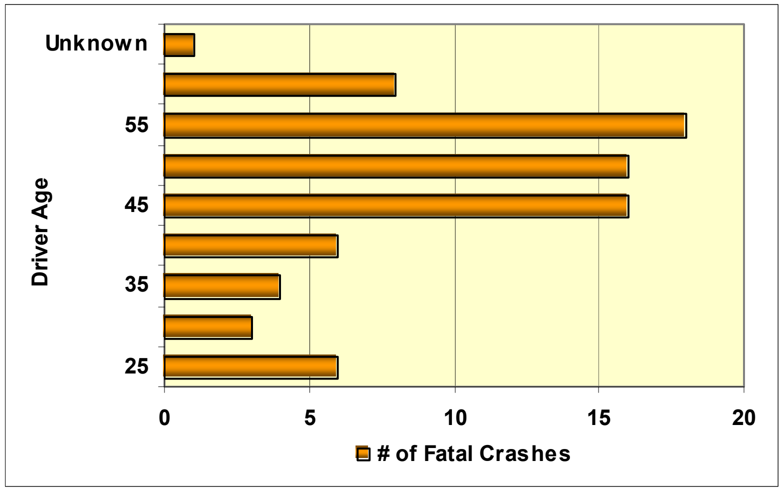


Exhibit 33 shows the posted speed limit at the location of the crash occurrence. As the majority of the fatal truck crashes in Maine occurred on non-Interstate facilities, the majority of the posted speed limits were 55 miles per hour (mph) or less.

Exhibit 33: Fatal Truck Crashes by Posted Speed Limit



Summary Conclusions About Safety & Weight Policy

The safety analysis for this study:

1) Examined national trends for fatal crashes involving large trucks,
2) Provided a detailed examination for three years of geo-coded crash records looking specifically at 5 and 6-axle TST vehicles in Maine;
3) Conducted a comparative analysis of truck crash statistics for Maine as compared to other states and national averages, and;
4) Constructed fatal truck crash profiles for three years of crash records from Maine.

The most prominent findings from this investigation are:

- ✓ The crash rate experience of 5 and 6 axle TST combination vehicles registered to carry commodities at the weights under study are 7 to 10 times higher on non-Interstate facilities in Maine, than on the Maine Turnpike. These findings are consistent with national studies that have found a strong relationship between road class and crash risk, with fatal crash rates on rural Interstate highway facilities 300 to 400 percent less than other types of rural roadways (i.e. trucks traveling on rural interstates are 3 to 4 times less likely to have a fatal crash than trucks traveling on rural state and county highways).

- ✓ If the current weight exemption on the Maine Turnpike were extended to non-exempt Maine Interstate Highways, the net impact to Maine is estimated to be a <u>decrease</u> of 3.2 crashes annually. The associated FHWA defined economic impacts would be $356,000 per year.

- ✓ Nationally, the safety of large trucks (and combination trucks in particular) has shown dramatic improvements in safety as measured by fatal crash rates.

- ✓ The state comparison analysis also found no correlation between states that allow normal GVW in excess of 80,000 lbs. on state networks and high crash rates; in fact, the regression analysis found a positive correlation between low crash rates and high load factors. And, in comparison to other states the crash rate for TST combination vehicles in Maine was slightly below the national average.

Pavement Analysis

> **Pavement Fatigue**
>
> "The break-up of pavements is usually caused by fatigue. Fatigue or fatigue cracking is caused by many repeated loadings and the heavier the loads the fewer the number of repetitions required to reach the same condition of cracking. It is possible, especially for a thin pavement, for one very heavy load to break up the pavement in the two wheel paths. To account for the effect of different axle weights, the relative amount of fatigue for an axle at a given weight is compared to that of a standard weight axle. Historically this standard axle has been a single-axle with dual tires and an 18,000-pound load."
>
> - Comprehensive Truck Size and Weight Study (USDOT, Dec. 2000)

State highway agencies design highway infrastructure based on predicted truck traffic volumes and axle weights. The majority of pavement wear (also referred to as pavement consumption) is attributed to heavy truck traffic. Currently the State of Maine spends roughly $50 million each year on pavement rehabilitation and preservation. From an operations and maintenance standpoint, vehicle axle loads and environment are the primarily determinants of pavement wear. Other factors affecting the wear-ability of pavements fall primarily to construction standards such as the type of sub-base, paving material and pavement thickness. Changes to TS&W policy can substantially impact the costs for pavement maintenance and rehabilitation. The objective of the pavement analysis conducted for this study is to relate the impact from changes in axle loadings under the policy scenarios to reflect pavement damage in terms of potential state expenditures. The approach taken in this study uses pavement consumption factors referred to as Equivalent Single Axle Loads (ESAL) to estimate changes in pavement wear.

ESAL factors provide a means of readily assessing the relative damage resulting from loaded commercial vehicles on pavements. ESAL values are calculated to standardize the measurement pavement wear from a wide variety of trucks, carrying a wide range of loads. One ESAL is generally defined as one four-tired axle bearing an 18,000 lb. load.

Using an ESAL approach the damage or "consumption" of pavement from different vehicle loads are normalized by relating the damage to a standard reference axle weight (18,000 lb. single axle load). Road tests have established that the relationship between axle weight and pavement damage is a logarithmic function. For example, a 36,000 lb. single-axle load does approximately 20 times more damage than an 18,000 lb. single-axle load. So, even though the load is only twice the magnitude, the calculated ESAL factor is 21.2.[§§] (The example is based on a structural pavement number of 3 and a terminal serviceability level of 2.0). Thus, axle weight and pavement consumption exhibit a logarithmic relationship, making the analysis of many vehicles and pavement types difficult. Converting axle loads to ESALs prior to analysis allows the analysis of a straightforward, linear relationship wherein two ESALs consume twice the pavement as a single ESAL, and three ESALs consume three times as much, and so on.

[§§] Transportation Research Board (TRB), Transportation Research Record 1816: *"Cumulative Traffic Prediction Method for Long-Term Pavement Performance Models"* Christopher R. Byrum and Starr D,. Kohn, pp. 111

Pavement Cost Impacts Methodology

A methodology was developed to quantify the impact on pavement performance and cost characteristics from incremental loadings resulting from the study weight limit policy condition (i.e. allowing exempt weight 5- and 6-axle TST on currently non-exemption portions of the Maine Interstate System). The magnitude and pattern of truck traffic expected from implementation of the study policy scenario was calculated using a four step process:

- Assigning *base* (existing) truck traffic (vehicle classes 4-13) and ESAL loadings to the study network (derived from WIM stations);
- Assigning *study* truck traffic expected to divert from non-Interstate Highways given implementation of the study policy scenario;
- Calculate the *increment* in 5- and 6-axle volumes and associated ESAL loadings (positive or negative) between the base and study scenarios; and
- Calculate the cost impacts relating to the incremental ESAL loadings between the base and study scenarios.

The equation used in deriving ESAL factors for the analysis was that used at Maine's WIM stations, and is taken from the *1986 AASHTO Guide for Design of Pavement Structures*. MDOT's pavement management criteria uses a *structural pavement number* (SN) of 5 and a pavement "*terminal serviceability level"* (P_t) of 2.5. These criteria were used throughout the analysis. The follow equation was used in deriving ESAL factors from the WIM stations traffic data:

$$\beta\chi = 0.04 + \frac{0.081 \times (L_x + L_2)^{3.23}}{(SN+1)^{5.19} \times {L_2}^{3.23}}$$

Where L_x is the load on the whole axle group; L_2 is the axle group code (1 for single, 2 for tandem, 3 for tridem).

The pattern and magnitude of incremental traffic was identified through the distribution of commodity tonnage data purchased for the study, and supplemented with WIM data provided by Maine. The WIM station ESAL factors included the full range of 5 & 6 axle TST weights, including those above the exempt weight range, as recorded at the WIM stations.

Step 1: Base Scenario Vehicle / ESAL Traffic Distribution

The Base Scenario to reflect current truck traffic patterns was developed by assigning the 5- and 6-axle commodity tonnage data to the analysis network. In the base scenario, all analysis network links representing Maine non-exempt Interstate system facilities were *disabled* so that commodity tonnage data could not be assigned to those links. Thus, the only links that the commodity tonnage data could be assigned to in the base scenario were:

- State system facilities; and
- The Maine Turnpike

The conversion process described in **Appendix C** was then used to convert assigned tons to numbers of 5- and 6-axle trucks. Then, the ESAL factors described found in **Table C-1** of the appendix were used to convert truck volumes to ESALs.

Step 2: Study Scenario Vehicle / ESAL Traffic Distribution

To develop the study scenario, the links previously *disabled* in the base scenario (that is, the non-Turnpike Interstate facilities) were *enabled*. This yielded an analysis network representative of the study condition – one where *all* Maine Interstate facilities could legally bear 5 and 6-axle vehicles weighing between 80,000 and 100,000 lbs. Again, the conversion process described in **Appendix C** was used to convert assigned tons to numbers of 5- and 6-axle trucks.

Step 3: Comparison of Base and Study Scenarios

The diversion network developed for this study is composed of roadway facilities both having heavy truck traffic drawn *from* them, as well as those having heavy truck traffic drawn *to* them. A complete analysis of pavement impacts must account for both instances. In total, the analysis examined over 13,000 road segments. Comparisons of base scenario ESAL loadings on the diversion network were separated into those facilities that *lose* heavy truck traffic given implementation of the study scenario, and those that *gain* heavy truck traffic.

Step 4: Estimating Maintenance & Rehabilitation Budget Savings

It was assumed in this analysis that the percentage reduction (or gain) in ESAL loadings on facilities making up the diversion network will equate to an equal percentage in resurfacing cost savings (or increases) for that given type of roadway, based on existing MDOT expenditures. As such, it was necessary to develop a measure to describe the amount spent for each unit of pavement consumption by functional class of highway – system wide.

The table in **Exhibit 34** summarizes the incremental differences in truck volumes and associated ESAL loadings on the study network that where observed by model runs of both the base and study scenarios. As expected, if the federal weight exemption in force on the Maine Turnpike were extended currently non-exempt Maine Interstate Highways, 5 and 6 axle TST traffic on non-interstate highways types and the Turnpike would decrease, while traffic on other Interstate routes would increase.

Exhibit 34: Summary Impacts to Maine Pavements for the Study Scenario*

Functional Highway Class	Change in Daily Truck Miles from Current Condition			Change in Daily ESAL Miles from Current Condition		
	Five Axle TST	Six Axle TST	Total 5 & 6 Axle TST	Five Axle TST	Six Axle TST	Total 5 & 6 Axle TST
Major/urban collector	-899	-4,497	-5,396	-3,481	-18,799	-22,280
Minor arterial	-458	-2,292	-2,750	-1,774	-9,579	-11,353
Other principal arterial	-2,219	-11,096	-13,315	-8,588	-46,380	-54,968
Principal Arterial Interstate	4,001	20,007	24,009	15,486	83,631	99,117

Calculation of Base Pavement Use:

A prorating methodology was used to assign base scenario truck volume and ESAL estimates (vehicle classes 4-13) to the MDOT TIDE route system. Unlike in the development of the base and study scenarios, volume and ESAL calculations and assignments were made using MDOT classification volume counts and ESAL factors, not those derived from commodity tonnage data.

MDOT provided updated 2003 ESAL factors from its WIM stations allowing ESAL factors by vehicle classification for each WIM station to be developed. These ESAL factors were assigned to links on the MDOT TIDE route system based on the proximity of route links to a given WIM station. Using the previously-described distance-weighted prorate procedure, classified volumes and associated ESAL values were assigned to the Maine study network. Next, values for vehicle-miles and ESAL-miles were summarized for each functional system. Summarizing these values by functional system was used in determining cost impacts from implementation of the study scenario, as the MDOT resurfacing program budget is partitioned by functional system.

Development of Base Unit Costs:

MDOT provided historical cost details about their pavement resurfacing program, representing the *entire* mileage for each functional system. System-wide programmed pavement maintenance was used to develop a *cost per ESAL-mile* normalized for each functional system element, which were then applied to the study network. It was assumed that historically pavement budgets would be programmed to system elements based on their need and that historical maintenance needs would be linked to the number of axle loads (expressed as ESALs) traveling over those systems. The cost per ESAL-mile factor was applied to incremental ESAL loadings (positive or negative) to determine cost impacts for the study scenario. The pavement resurfacing cost calculations is summarized in the table of **Exhibit 35.**

* For purposes of this analysis, the functional system "Principal Arterial – Other Freeways & Expressways" has been grouped with "Other Principal Arterial."

Exhibit 35: MDOT Resurfacing Cost per ESAL-Mile by Functional System

Functional Highway Class	Known ESAL-Mi. Vehicle Class 4-13	Assoc Length: Known ESAL-Mi.	Total System Length (Mi)	Expanded ESAL-Miles	98-'05 MDOT Program (Low)	98-'05 MDOT Program (High)	Cost / ESAL-Mi. (Low)	Cost / ESAL-Mi. (High)
Major/Urban Collector	518,827	1,568	3,739.30	1,237,316	$14,545,380	$31,649,670	$11.76	$25.58
Minor Arterial	592,553	1,117	1,327.80	704,550	$16,832,350	$33,707,880	$23.89	$47.84
Principal Arterial - Other	870,496	892	981.3	958,148	$18,478,700	$25,929,400	$19.29	$27.06
Principal Arterial - Interstate	1,318,870	302	366.8	1,601,753	$9,558,000	$15,344,000	$5.97	$9.58

Because the Maine Turnpike and parallel non-turnpike sections of the Maine Interstate System are classified as *"Principal Arterial – Interstate"* the change in ESAL miles represents a net impact. The model suggests that if currently non-exempt Maine Interstate Highways were allowed to carry study weight vehicles, the section of the Maine Turnpike north of Portland would lose traffic to the previously non-exempt Interstate between Yarmouth and West Gardiner. The model results are presented in **Exhibit 36.**

Exhibit 36: Turnpike Interstate Diversion Summary

Facility	Length (Mi)	ESAL-Mi: Base Scenario	ESAL-Mi: Study Scenario	Change
Non-Turnpike Interstate	346	370,878	510,205	139,327
Turnpike	52	40,210	0	-40,210
Principal Arterial Interstate – Net Change				99,117

Exhibit 37 shows results from the methodology used to calculate the change in annual pavement maintenance costs. Using the historical high and low allocation provides an expected *range of cost impacts.* These values are represent the cost (or savings) that would be realized through the addition (or removal) of one ESAL-mile to a given functional system. **It is estimated that if the current Turnpike Exemption were extended to all Maine Interstate Highways the policy would save the State of Maine between $1 million and $1.65 million in pavement rehabilitation costs each year.**

Exhibit 37: Cost Impacts to MDOT Resurfacing from Interstate Weight Exemption

Functional Highway Class	Change in Daily ESAL Mi.	'98-'05 MDOT Resurfacing Cost/Daily ESAL-Mile (Low)	'98-'05 MDOT Resurfacing Cost/Daily ESAL-Mile (High)	Change in MODT Resurfacing Program (Low)	Change in MODT Resurfacing Program (High)
Major/urban collector	-22,280	$11.75	$25.58	($261,890)	($569,853)
Minor arterial	-11,353	$23.89	$47.84	($271,207)	($543,109)
Other principal arterial	-54,968	$19.29	$27.07	($1,060,331)	($1,487,862)
Principal Arterial Interstate	99,117	$5.97	$9.58	$591,542	$949,635
			Total Savings	**($1,001,886)**	**($1,651,189)**

Bridge Analysis

Bridges represent critical links and potential bottlenecks in highway transport systems for freight. The impacts of truck size and weight on bridge stress and fatigue remains one of the more controversial issues associated with truck regulatory policy, due to the complexity in analyzing a wide variety of structures and the high costs associated with bridge replacement. The current federal bridge formula (FBF) also represents the limiting factor in current gross weight policy on the Federal Interstate Highway System.

Exhibit 38: Maine Bridges

Functional Highway Class		No. of Bridges
Rural	Principal Arterial - Interstate	177
	Principal Arterial - Other	133
	Minor Arterial	186
	Major Collector	458
	Minor Collector	268
	Local	746
Urban	Principal Arterial - Interstate	96
	Principal Arterial - Other freeway/expressway	21
	Principal Arterial - Other	70
	Minor Arterial	77
	Collector	81
	Local	50
	Totals	**2,363**

The National Bridge Inventory System (NBIS) lists 2,363 bridges in the State of Maine. The table in **Exhibit 38** provides an inventory of bridges by functional highway class in Maine. Of the more than 2,000 bridges in Maine, approximately 12% are located on the Interstate Highway System.

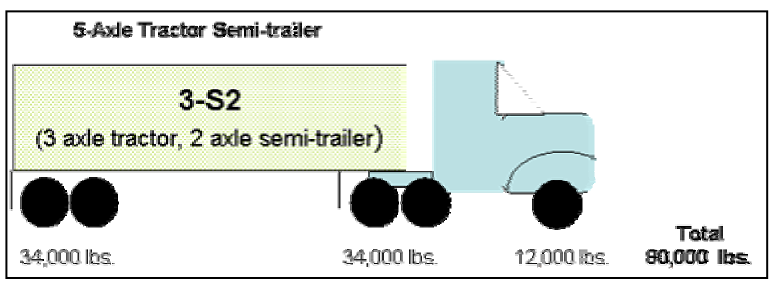
Bridge Impacts Analysis Methodology

The Three Loading Cases that were considered are as follows:

Case 1: 80,000 lb. Truck, Base Loading: corresponds to a "3-S2" (**Exhibit 39)** with the following axle load distribution:

- Steering Axle = 12,000 Lb.
- Forward Tandem Axle = 34,000 Lb.
- Rear Tandem Axle = 34,000 Lb.

Exhibit 39: Five-Axle TST Base Vehicle



(Note: Maximum tandem axle load under Maine General Law, assumed to be spaced at 14 ft from the front steering axle to the centerline of the tandem axle. For simple spans, use shortest allowable total wheelbase of 51' as per the Federal Bridge Formula (FBF).

Case 2: 88,000 Lb. Truck, 5-Axle Loading Case: Also for a 3-S2 vehicle (**Exhibit 40)** with the following axle loading distribution:

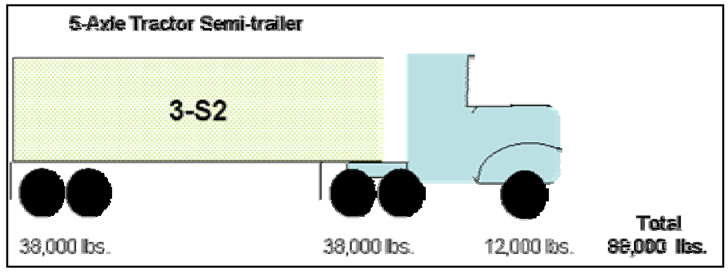
- Steering Axle = 12,000 Lb.
- Forward Tandem = 38,000 Lb.

(Assumed to be spaced at 14 ft from the front Steering Axle to the centerline of the Tandem Axle)

- Rear Tandem = 38,000 Lb.

(With a total wheel base of 59')

Exhibit 40: Five-axle TST Study Vehicle



Case 3: 100,000 Lb. Truck, 6 Axle Loading Case: Corresponds to a 3-S3 vehicle (**Exhibit 41)** with the following axle loading distribution:

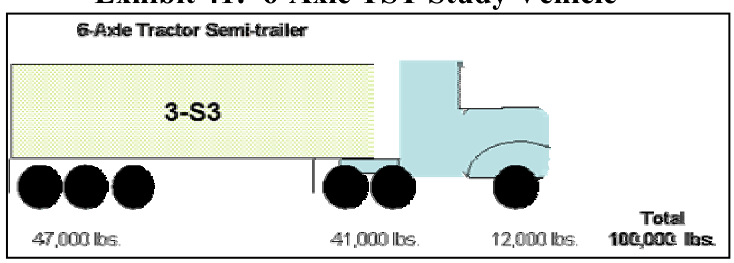
- Steering Axle = 12,000 Lb.
- Forward Tandem = 41,000 Lb.

(Assumed to be spaced at 12 ft from the Steering Axle)

- Rear Tri-axle = 47,000 Lb.

(Spacing of 32 ft center of tandem axle to center of the tri-axle, with a total wheel base of 50')

Exhibit 41: 6-Axle TST Study Vehicle



Note: It is acknowledged that other axle configurations and axle weight distributions maybe legally allowed in Maine and that Cases 2 and 3 trucks do not meet the federal bridge formula. Cases 2 and 3 are assumed to be the most representative of the exempt weight trucks currently operating in Maine.

The cost impacts upon Maine bridges due to the GVW policy change under consideration were analyzed from two different perspectives:

1. The increase or decrease in normal wear and tear and its associated maintenance.
2. The long term effect of the loading with regards to fatigue of the bridge superstructure.

Two groups of bridges were analyzed in conducting the analysis:

Group 1) Bridges on the Maine Turnpike between Mile Points MP 3.68 and 50.96

Group 2) Bridges located on State Routes which would be impacted due to changes in truck traffic due to the Non-Exempt scenario.

For each group of bridges, the study developed truck volumes by vehicle type, which apply for the three loading cases:

The Non-Exempt Scenario for:	a.)	80,000 lb. truck - federal weight limits
The Study "Exempt" Status for:	a.)	88,000 lb. 5 axle truck, and
	b.)	100,000 lb. 6 axle truck

Available bridge inventory data was obtained and reviewed for the bridges being considered. MDOT provided Structural Inventory and Appraisal (SI&A) data for each bridge, including: year built, structure type, condition ratings, number of lanes and spans, Inventory and Operating Load Ratings, traffic data (AADT, per cent of trucks and the year AADT was taken), etc. The list of bridges analyzed for the analysis can be found in **Appendix D.** The bridges to be considered were defined by construction material, structural type and relative span length. The maintenance cost analysis, was conducted for all structures with bridge decks. Structures under fill were excluded as they do not have a deck that comes in contact with the wheels.

The longer term effects of exempt weight vehicles were studied by investigating the change in bridge fatigue life. Concrete bridges were not include in the long term impacts analysis, as they are relatively unaffected by fatigue. Steel bridges were grouped by span length, overall length and span configuration. Cost estimates were developed (in 2003 dollars) for two cost categories:

1) Periodic Maintenance - Costs are based on historic cost records and published references.

2) Major Rehabilitation - Based on accepted average costs

Because the fatigue analysis indicated that the normal life cycle of the structures would not be significantly affected, replacement costs were not estimated.

Periodic Maintenance Costs: The structure elements most affected by increasing or decreasing loadings on a bridge, are the bridge deck, deck joints, and scuppers. While the axel loads of the study vehicles are not significantly heavier than the standard "HS-20" design truck, their larger load will result in an accelerated deterioration of the deck elements.

Maintenance and rehabilitation costs are based on the length and width of the bridges. This information was supplied by the MDOT and supplemented when necessary from the National Bridge Inventory System (NBIS). *(Assumptions used in calculating maintenance costs can be found in Tech Memo 3B).* Cost impacts (increase or decrease) were calculated for each bridge depending on how the policy change under study would affect the structure. On bridges that no longer carry as much exempt weight traffic, maintenance costs decrease, on structures with more exempt weight vehicles maintenance costs increase. The maintenance costs were weighted for several ranges of truck volume change. A change of 5 or fewer trucks per day due to a change in policy was assumed to have little or no effect on the structures. For volume changes greater than 75 trucks per day, the full cost factor of 1 (-1) was used. The cost factor was reduced for volume changes between 5 and 75 in one third increments, i.e.; 5 to 35 trucks per day yielded a cost factor of 0.33 (-0.33) and 35 to 75 trucks per day yielded a cost factor of 0.67 (-0.67). The maintenance cost estimates by structure are presented in the table in **Exhibit 42**:

Exhibit 42: Maine Bridge Maintenance Cost Impacts

Primary Route	Bridge Name	Town Name	MAINTENANCE COST CATEGORY Deck Repair	Deck Joint	Scupper Repair
INT 295 NB	CNR CROSSING	Portland	$84,983	$8,498	$503
ST RTE 002	CONGRESS STREET	Portland	$0	$0	$0
INT 95 NB	FORE RIVER	Portland	$0	$0	$0
TURNPIKE	MEADER BROOK	Falmouth	$0	$0	$0
ST RTE 011	GILBERT SMALL	Windham	$0	$0	$0
TURNPIKE	COLLIER BROOK	Gray	($10,500)	($6,300)	($500)
TURNPIKE	FOREST LAKE BROOK	Gray	$0	$0	$0
TURNPIKE	PLEASANT RIVER	Gray	($10,500)	($6,300)	($500)
ST RTE 002	MIDDLE RANGE	Poland	($2,650)	($1,178)	($168)
ST RTE 012	RTE 122/OLD HOTEL RD	Auburn	$0	$0	$0
TURNPIKE	FOSTER BROOK	New Gloucester	$0	$0	$0
US 1	RT #1 UNDERPASS	Brunswick	$0	$0	$0
RD INV 101	PAUL DAVIS MEMORIAL	Bath	($26,577)	($3,457)	($503)
US 1	WEST APPROACH	Bath	($221,996)	($6,205)	($1,340)
ST RTE 014	CORBETT	Salem Twp	$0	$0	$0
US 2	WILD RIVER	Gilead	$17,107	$1,584	$330
US 2	PEABODY SCHOOL	Gilead	$1,767	$832	$83
ST RTE 003	CRYSTAL LAKE OUTLET	Harrison	$7,316	$2,251	$168
ST RTE 003	HORRS	Waterford	$9,472	$1,166	$168
US 2	PROSPECT AVE	Rumford	$3,926	$1,083	$83
ST RTE 010	MORSE	Rumford	$17,634	$495	$83
ST RTE 012	CNRR	Mechanic Falls	$0	$0	$0
ST RTE 001	MECHANIC FALLS	Mechanic Falls	$0	$0	$0
ST RTE 002	SAW MILL	Paris	$0	$0	$0
ST RTE 010	FROST	Rumford	$0	$0	$0
ST RTE 014	MILL POND	Salem Twp	$0	$0	$0
TURNPIKE	CITY FARM CULVERT	Lewiston	$0	$0	$0
US 202	JAMES B. LONGLEY MEM	Auburn	$0	$0	$0
ST RTE 001	PARSONS MILL	Auburn	$0	$0	$0
ST RTE 013	IRON	Auburn	$0	$0	$0
ST RTE 013	MAIN ST. BRIDGE	Auburn	$0	$0	$0
ST RTE 019	LOCUST ST BRIDGE	Lewiston	($8,437)	($758)	($83)
US 202	MAIN STREET	Lewiston	$0	$0	$0
US 202	JEPSON BROOK	Lewiston	$0	$0	$0
US 202	FAIRGROUNDS CROSS	Lewiston	$0	$0	$0
ST RTE 019	DILL	Lewiston	$0	$0	$0
TURNPIKE	NO NAME BROOK CULV	Lewiston	$0	$0	$0
TURNPIKE	NEWOEGIN CULVERT	Sabattus	$0	$0	$0
ST RTE 012	SABATTUS RIVER	Sabattus	$0	$0	$0
ST RTE 000	BRETTUNS POND	Livermore	$0	$0	$0
ST RTE 021	FOSS	Leeds	$11,385	$487	$83
ST RTE 0197			$0	$0	$0
TURNPIKE	POTTERS BROOK	Litchfield	$0	$0	$0
ST RTE 019	PLEASANT POND	Richmond	$0	$0	$0

Primary Route	Bridge Name	Town Name	MAINTENANCE COST Deck Repair	Deck Joint	Scupper Repair
ST RTE 019	BARKER BROOK	Richmond	$0	$0	$0
INT 95 Nort	VAUGHN STREAM	Hallowell	$0	$0	$0
ST RTE 000	NEW MILLS	Gardiner	($23,625)	($1,500)	($250)
US 201	BRIDGE STREET	Gardiner	($80,682)	($7,140)	($1,000)
US 201	WATER STREET	Hallowell	($13,950)	($900)	($250)
ST RTE 004	GRIST MILL	Mt Vernon	$0	$0	$0
ST RTE 004	VILLAGE	Vienna	$0	$0	$0
ST RTE 002	BELGRADE LAKES	Belgrade	$13,081	$1,434	$248
RD INV 102	WATER ST BR. UNDERP	Augusta	$0	$0	$0
US 201	AUGUSTA MEM BRIDGE	Augusta	($708,075)	($8,100)	($1,250)
RD INV 100	FATHER JOHN J CURRAN	Augusta	$0	$0	$0
US 2	HARDY BROOK	Farmington	$0	$0	$0
ST RTE 000	MILL POND	Farmington	$0	$0	$0
ST RTE 001	PROCTOR BROOK	New Portland	$0	$0	$0
US 2	MAIN STREET	Norridgewock	$0	$0	$0
US 201	COLLEGE AVE CROSSING	Waterville	($16,191)	($1,085)	($335)
US 201	WYMAN CROSSING UND	Fairfield	($27,884)	($1,869)	($335)
US 2 –South	MARGARET CHASE SMITH	Skowhegan	($45,179)	($2,979)	($335)
US 2 - North	MARGARET CHASE SMITH	Skowhegan	($38,737)	($2,348)	($168)
US 201	WOOLEN MILL	Skowhegan	($2,652)	($964)	($83)
US 201	MAIN ST BR.	Fairfield	($13,266)	($965)	($168)
ST RTE 001	CAIN	Clinton	($3,687)	($983)	($165)
ST RTE 015	PARKMAN RD / FERGUSON	Cambridge	($1,731)	($602)	($83)
US 2	MAIN STREET	Newport	($40,891)	($4,523)	($838)
ST RTE 000	CORINNA	Corinna	$0	$0	$0
ST RTE 000	GUILFORD MEMORIAL	Guilford	($17,325)	($1,188)	($165)
US 1	MAIN STREET	Camden	($5,977)	($2,049)	($165)
US 1	LINCOLNVILLE BEACH	Lincolnville	($1,282)	($733)	($83)
US 1	STOCKTON SPRINGS UND	Stockton Sprgs	($32,858)	($4,044)	($750)
US 202	WARD	Newburgh	$0	$0	$0
US 1A	TIN	Bangor	$0	$0	$0
INT 395 EB	MCRR/I-395	Brewer	$23,688	$1,512	$500
US 2	STATE ST.	Bangor	($17,237)	($2,132)	($165)
US 1A	JOSHUA CHAMBERLAIN	Bangor	($152,261)	($2,590)	($413)
ST RTE 000	PENOBSCOT BRIDGE	Bangor	($140,086)	($4,200)	($495)
US 2	RED	Bangor	($4,749)	($2,111)	($168)
US 1	MAIN STREET	Ellsworth	($57,710)	($7,305)	($1,000)
US 2	SMITH BROOK	Lincoln	$0	$0	$0
US 2A	JORDAN MILL	Macwahoc Plt	($9,867)	($1,548)	($168)
US 2A	MILL	Haynesville	$0	$0	$0
US 2A	HAYNESVILLE	Haynesville	($47,094)	($2,653)	($503)
US 1	STONEY BROOK	Baileyville	$0	$0	$0
US 1	B&ARR/US RTE 1 RR#208	Presque Isle	($3,695)	($374)	($83)
US 1	CLARK	Presque Isle	$0	$0	$0
RD INV 004	FARNHAM BROOK	Pittsfield	$0	$0	$0
			($1,596,988)	**($69,741)**	**($10,260)**

The maintenance costs presented in **Exhibit 42** were calculated based on a five year maintenance period. When annualized, extending the current federal weight exemption on the Maine Turnpike to all currently non-exempt Maine Interstates is expected to decrease annual maintenance expenditures $335,398 per year.

Major Rehabilitation Costs: The cost for major rehabilitation was based on the total square feet of the bridges analyzed. The type of treatments considered under the major rehabilitation costs would include deck replacement; including deck joint and drainage system replacement, approach slab replacement, repainting, structural repair of corrosion and deterioration, and safety improvements. A major rehabilitation project as described above would be necessary every 25 years on average. Increased wear and tear on the structures could reduce this interval by as much as 5 years. With a five year reduction in the rehabilitation interval, it may be necessary to perform major rehabilitation more than once in the structure's life. This would most likely be economically sound for longer structures that would have higher replacement costs. For purposes of this study, it is assumed that increasing truck weights would result in a second major rehabilitation project being performed on structures over 200 feet in total length. Only two structures, both in Maine fell into this category.

Route #	Town	Bridge Name	Rehabilitation Cost
U.S. 2	Gilead	Wild River	$228,096.00
Route 108	Rumford	Morse	$235,125.00
25 – Year Rehabilitation Cost Total			**$463,221.00**

The total estimated rehabilitation cost for these two structures was $463,221.00. Since the major rehabilitation costs were based on a 25 year horizon, the annualized cost for major rehabilitation on the two structures would be $18,528.84 per year.

The bridge analysis found that extending the federal weight exemption currently in place on the Maine Turnpike would result in annual bridge maintenance and rehabilitation savings of $316,869.00 per year.

Other Economic and Social Impacts

Impacts to Shippers and Carriers of Heavy Commodities

The consultant team also interviewed 15 companies in Maine that ship or haul heavy commodities, primarily timber, bulk liquids, stone and aggregates, garbage and heavy equipment. Phone interviews with these companies were conducted over two different periods during the course of the study. In addition to gaining information about preferred routes under various weight policy scenarios, the survey questionnaire also asked companies how they felt about the current federal weight policy on the Interstate System in Maine. The second round of interviews included some additional questions regarding truck equipment, driver pay and self-policing of loaded weight. These questions were added at the request of the study review panel.

Nearly all respondents (88%) indicated that the current weight limit exemption on the Maine Turnpike was either "essential" or "very important" to their businesses. Respondents believed that Interstate facilities are the safest roadways; these highways are away from population concentrations, the roads are multi-lane, well maintained, and enable overall less time on the roadway for the transportation of heavy or dangerous commodities. Sample comments from the interview process are listed below:

- *"The exemption is important for the cost effectiveness of the fleet as well as for the raw materials coming into our facility. Being able to carry 20,000 lbs more per load is critical for the business."* (Note: 20,000 lbs. of additional weight would apply only to 6 axle configurations).
- *"Safety is our biggest concern. The interstate, including the Maine and New Hampshire Turnpikes are the safest roads for heavy vehicle operations and petroleum transport."*

On the whole there was considerable consternation regarding the inability to legally use the non-exempt portions of I-95 in Maine. The primary reasoning from the respondents was that the interstates were built to carry heavier loads. Several mentioned that the system was originally designed as the national military network and therefore was also equipped to carry their heavy loads. A number of others interviewed could not understand the reasoning of forcing heavy vehicles onto state routes where they were required to go through population centers, deal with congestion and tourists, and in general, create increased opportunity for a major catastrophe whether it would be loss of life or contamination of a waterway/seashore. One respondent was convinced that it would take such a major event to begin the process of change.

Companies generally responded that the exemption on the Maine Turnpike saves time and money, observing that Interstate Highways are "built better." The general comment was that everyone wins; Interstates are better able to handle heavy loads and easier to maintain. Respondent believed that weight enforcement is easier as well, noting that weigh-in-motion stations can be used more effectively on exempt Interstate routes because they would be the routing of choice for all heavy haulers.

A smaller population of carriers was questioned about equipment. About 40 percent of the TST combinations operated by the companies had 5 axles. The remaining 60 percent were 6-axle combinations. About 90 percent of the 5-axle vehicles were eligible to haul 88,000 lbs. All of the six-axle TST combinations were eligible to haul up to 98,000 to 100,000 lbs. All but one of these trailers had a tridem axle. In addition, respondents reported that all but a very few of the tridem axle trailers were original equipment with the remaining few being retrofitted to the trailer at some point after the initial purchase. The companies reported having a range of suspension systems including; springs, air-ride and a combination of both.

When asked about six-axle TST equipment respondents were not aware of any complaints with the performance or operation of six-axle vehicles greater than 80,000 lbs GVW. In fact a number of the respondents said the six-axle vehicles had better braking capabilities, more stability, and generally had greater power for keeping up to speed in the traffic flow.

Nearly every company interviewed had some strategy to assure that their vehicle loads did not exceed legal weight limits. Petroleum product haulers all reported that they knew the weight of the product and the capacity (volume) of each of their vehicle configurations, which assures a legal limit. Like the petroleum product haulers, the cement and asphalt haulers interviewed also knew the amount of product their vehicles could carry and the associated weight. Stone and aggregate haulers reported that they had yard scales which they use to check loads. One dispatcher responsible for checking vehicle weights, said: *"The vehicles do not go out of the yard prior to weighing and assuring a legal load."* Some vehicles operated by a forest product hauler were equipped with on-board scales. (This was the only company with such equipment.) This company also paid drivers by the hour, so there is no advantage to overload. A petroleum products hauler noted that if a driver gets fined for carrying an overweight load, the driver must pay the fine. One company stated that they relied on driver experience, noting that there were a lot of available scales.

Driver wages varied depending on several factors: the type of vehicle, the experience of the driver, and the hours/days worked per week. Sample responses included the following:

- $12 - $20 per hour depending on the type of vehicle
- $15 - $20 per hour
- $650 - $850 per week for a good driver with either a 56 or 60 hour work week
- $40,000 - $50,000 per year with either a 56 or 60 hour work week
- $27,000 - $30,000 per year, 5 days per week – home every night
- $14 per hour

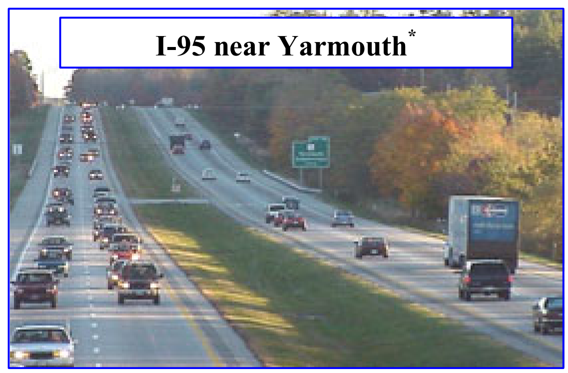
Including all the responses produces an average wage of $15 per hour wage.

Impacts to Communities


U.S. Route 1 through Searsport*

Thirteen city officials from seven towns in Maine were also contacted for their opinions about the federal weight policy on the Interstate Highway System in Maine. Questions focused on three areas, impacts of large trucks in the community, complaints to the town or city about large trucks, and anecdotal information about truck crashes in the community.

The interviewee's concepts of impacts of the large trucks traveling on the town or city streets mirrored the complaints received from community members. The issues centered on safety, traffic congestion, air and noise pollution, road maintenance, economic consequence to business and disturbance of the pleasant village center ambience.


I-95 near Yarmouth*

Overall, impacts of large trucks in these communities are considered very significant. In fact, without exception, every local official interviewed expressed strong personal and community support for allowing large, heavy trucks on the interstate system in Maine. One city manager said, "I don't know a single local official [in Maine] who wouldn't want big trucks on the interstate." Another said, "It is a poor policy to not have the big trucks on I-95."

The police chiefs contacted indicated that bringing large trucks through downtowns created unnecessary safety hazards, especially if these trucks were transporting hazardous materials. Alternate routes like U.S. 1 are heavily used by tourists and often bring traffic through historic city centers.

Without exception, every local official interviewed expressed strong personal and community support for allowing large, heavy trucks on the Interstate System in Maine. A summary of the interviews conducted can be found in **Appendix B.**

* Photos courtesy of PACTS

Related Studies

There have been a number of recent studies, examining the implications of changing truck size and weight policy at a state or national level, including the TEA-21 mandated studies in Colorado and Louisiana. Two prominent examinations of U.S. truck size and weight policy were also conducted, one by the U.S. Department of Transportation (USDOT), and the other by the Transportation Research Board (TRB). Here is a brief summary of these study findings.

Regulation of Weights, Lengths, and Widths of Commercial Motor Vehicles – TRB Special Report 267, (2002):[***] Also requested by Congress in TEA-21. This committee report is based primarily on the review of previous studies and the opinions of an expert panel:

- The study's first recommendation concludes: "***Opportunities exist for improving the efficiency of the highway system through reform of federal truck size and weight regulations***. *Such reform may entail allowing larger trucks to operate. Present federal standards are for the most part the outcome of a series of historical accidents instead of a clear definition of objectives and analysis of alternatives. The regulations are poorly suited to the demands of international commerce….The greatest deficiency of the present environment may be that it discourages private- and public-sector innovation aimed at improving highway efficiency and reducing the costs of truck traffic…"*
- On the topic of size and weight as it relates to safety: "*The committee found that previous studies tend to correlate increases with truck size and weight to reductions in vehicle miles of travel (VMT), lowering the inherent risk due to exposure and hence reduce the overall potential for truck crashes.*
- On pavement wear related to TS&W, the panel concluded: *"If axle weights are not altered, pavement cost per ton-mile of freight will be little affected by a change in the gross vehicle weight limits.*
- On bridges: "*Bridge cost estimates derived by the method of past studies assume replacement of bridges regardless of whether the cost of replacement is justified by the gain in safety and do not fully take into account the capabilities of highway agencies to maintain bridge safety by more cost-effective means than replacing all suspect bridges..."*

The Comprehensive Truck Size and Weight Study (CTSWS), FHWA (2000)[†††] was undertaken to develop a policy architecture that would allow state and regional practitioners to analyze changes in truck size and weight at a sub-national level. Among the key findings of that study:

- "There are…several key trends that are evident relative to truck safety in general and size and weight policy choices in particular. First, numerous analyses of crash data bases have noted that truck travel, as well as all vehicle travel, on lower standard roads (that is, undivided, higher speed limit roads with many intersections and entrances) significantly increases crash risks compared to travel on Interstate and other high quality roadways. **The majority of fatal crashes involving trucks occur on highways with lower standards…. The [fatal crash] involvement rate on rural Interstate highways is 300 percent to 400 percent lower than it is on other rural roadway types and is generally the same for all vehicle types.**"
- The pavement Load Equivalency Factors presented in the report indicated that while a single six-axle TST vehicle operating at 97,000 lbs. is slightly more damaging to flexible pavements, when the

[***] Transportation Research Board, National Research Council; *Regulation of Weights, Lengths, and Widths of Commercial Motor Vehicles;* Special Report 267, National Academy Press, Washington D.C. 2002. pp. 2-39 to 2-45.
[†††] available online at www.fhwa.dot.gov/policy/otps/truck/

reduction in trips to move a given quantity of freight is factored in, the heavier vehicle actually produces less damage for both rigid and flexible pavements. The report concluded that the use of a 97,000 lb. six-axle TST in favor of five-axle, 80,000 lb. TST would result in nationwide VMT reduction of approximately 10% and pavement cost savings. The study indicated that heavier trucks would increase highway agency and user costs associated with bridge replacement and maintenance.

EFFECT OF TRUCK WEIGHT ON BRIDGE NETWORK COSTS: The National Cooperative Highway Research Program (Project 12-51) – TRB (Draft Final Report, December 2002):

- *The current AASHTO fatigue truck model developed over a decade ago is found still valid for current truck traffic, based on the current WIM data used.*
- *The current AASHTO fatigue truck model may still be valid for a scenario of legalizing higher truck weights if thereby introduced new dominant truck configurations are not significantly different from the currently dominant 3S2 configurations.*
- *Truck wheel loads are important to RC deck fatigue. More research efforts are needed to understand and model their magnitude and effects in the field. One of the factors needing investigation is the interactive effect of steel reinforcement corrosion and wheel load induced concrete fatigue.*

State weight exemption studies mandated by TEA-21:

Preliminary Assessment of Pavement Damage Due to Heavier Loads on Louisiana Highways, LTRC, May 1999. Ref. No. FHWA/LA-98/321.:

- *"**Comparisons of NPW between the weight scenarios showed that increases in GVW have more effect on Louisiana state and US highways than on Interstate highways.** Any elevation in GVW over current limits increases the cost of overlays and decreases the length of time before an overlay is required. The cost increase due to raising the GVW is substantial. Fee structures need to be modified by the state legislature to pay for these costs through the current registration and overweight permit fee structure or some new tax such as a ton-mile tax."*[5]

Non-divisible Load Study, Colorado DOT, June 2001:

- *"The law change has been beneficial to the Colorado taxpayers. There is an increase in property, sales and income taxes from this industry. However, the highway trust fund suffers a negative impact due to less fuel taxes. Jobs are created in Colorado, and other businesses benefit form lower costs due to increase competition in building choices."*

- *"Negative impacts are minor. There is an increase in load on bridge structures. However due to axle load limitations still in place on the permits, and the fact that the loads are generally carried on major routes, there are no significant problems. There are negative impacts to the pavements of Colorado highways due to the increased weights of the loads. There is anywhere from a 5% to 20% increase in pavement damage due to increased loads. However, since the bulk of the routes traveled are designed to carry heavy loads, the VMT are small, for this industry only, the impacts are not significant."*[6]

Public Comments to the Draft Report

During February 2004, MDOT placed the draft report and executive summary on its web site. MDOT issued a press release announcing the availability of the draft study report, and to provide notice that a public meeting to hear comments on the draft would be held on March 5th.

Public Meeting Response

Twenty-two people representing Maine towns and cities, industry and the general public signed in at the public meeting held at MDOT headquarters in Augusta on March 5th. After a 45 minute presentation summarizing the study results, attendees were invited to comment. All comments were recorded for the public record, and a more extensive summary of all public comments are presented in **Appendix E.** Of the eleven people commenting for the record at the public meeting, all spoke in support of the study findings, and further expressed support for extending the weight exemption on the Maine Turnpike to all Interstate highways in Maine. Comments were provided by city officials from Augusta, Bangor, Brewer, Freeport and Houlton. The primary points made by public officials included:

- City engineers commented that pavement costs for secondary roads may be understated. They pointed out that the study did not include local investments and that overall the level of public investments in secondary roads has been inadequate over the past decade or more. As a result secondary roads have continued to deteriorate over time. Using required investment as opposed to historical investment would likely produce greater benefits from an Interstate exempt policy
- While heavy truck transport is important to Maine's ability to support NAFTA trade, tourism is also very important. Many towns on the secondary road system are tourist destinations and public officials indicated having heavy trucks traveling through downtown areas is unnecessary.
- Several city officials indicated that they would have preferred to have the study address emissions, especially the impact of trucking idling in downtown areas.

Industry comments were provided by P.R. Russell Inc., Superior Carriers Inc. and Maine Motor Transport Association. Among the points made by industry members:

- Industry representatives reiterated the safety hazards of having to travel through downtown centers on the secondary road system.
- Comments also indicated that higher gross weight limits would reduce overall truck traffic, indicating that a 100,000 lb. truck can haul the same amount in three trips, as an 80,000 lb. truck hauls in four trips.

Sue Gilbert a homeowner along U.S. Highway 3, and parent of a school age child expressed her concerns about safety, and in particular the hazards presented to school buses:

- Ms. Gilbert indicated that she would like to see the study expanded to use additional crash data.
- She indicated that on a recent morning while waiting for the bus with her child, a truck came over the crest of a hill on U.S. 3 while the bus was stopped and loading. The truck driver applied his brakes, but was unable to stop in time and had to swerve around the bus on the shoulder. During the next two hours she counted 32 trucks pass by her house on U.S. Highway 3.

Written Comments from the Public

In addition to the comments about the study received during the public meeting, MDOT also received 39 written comments by mail or email. Of these comments, 24 opposed increasing weight limits on the Interstate system in Maine, 14 favored increasing the weight limit on Maine Interstates, and one expressed no opinion about the weight policy, but posed several questions about the study conclusions.

Letters supporting the Interstate weight exemption policy nearly all cited safety and noise concerns resulting from heavy trucks using the secondary road system.

Several comments opposing the Interstate exemption believed that all highways in Maine should be restricted to 80,000 lbs. One respondent suggested lowering the weight limit on state highways if an exemption were extended to Interstate highways. Several other respondents opposed raising the Interstate weight limit arguing that the exemption would increase diesel fuel consumption and harmful emissions. Of the 24 respondents opposing the policy to increase weight limits on the Interstate system in Maine, 16 provided comments through the use of a form letter containing the following language:

> *"I have just been made aware of the Maine DOT's study on truck traffic on I-95. This report recommends increasing truck weights to 100,000 pounds on the balance of I-95. I oppose this for the following reasons:*
>
> - *100,000 pound trucks are more dangerous.*
> - *100,000 pound trucks will still be operating on state highways, this is not going to solve Maine's problems of truck traffic on local roads.*
> - *This is just another attempt to slowly ratchet up the truck weights to the even more dangerous Canadian weights of 110,000 pounds to support the NAFTA trade agreement.*
>
> *I am opposed to efforts to expand the number of roads that allow more dangerous heavier trucks."*

In response to some of the comments received, MDOT posted a letter on its web site. A portion of that letter appears below. The full text of the letter is include in Appendix E.

> *"Some commenters suggested reduction of Maine State truck-weight limits as a proposed solution. This would aggravate rather than reduce the safety problem with heavier trucks. It would require up to 25% more vehicles to carry the same payload, resulting in more heavy vehicle exposure on our highways and intersections, thereby increasing the risk of truck-involved crashes. These extra vehicles will increase air pollutants and their adverse health affects. Economically, weight limit reductions would increase Maine transportation costs, a cost which would ultimately be paid by Maine consumers. Maine's economy would also be disadvantaged relative to other states, which allow higher truck weights."*[7]

Issues for Future Consideration

During the conduct of this study, several issues were discovered related to truck size and weight policy in Maine that merit additional investigation:

- The detailed analysis of WIM data indicate that some roadways experience significant populations of 5 and 6-axle vehicles exceeding legal weight limits. This study did not contemplate the infrastructure costs associated with illegal loads. However, the relationship between axle loads and pavement wear suggest that excessive axle weight contributes significantly to public infrastructure costs. As a result, future considerations of GVW policy in Maine should examine enforcement and permitting practices that discourage illegal loads.

- While the population of carriers interviewed was small, some companies reported using retrofitted trailers and walking-spring suspensions. Research on the interaction of commercial vehicles and pavements suggest that truck properties, such as number and location of axles, suspension type, and tire type, are important factors that influence the degree and magnitude of pavement wear. In addition, the US DOT's Comprehensive Truck Size and Weight Study found the performance of 6-axle TST combinations superior to the 5-axle TST in terms of stability and braking capacity.‡‡‡ While these factors were beyond the scope of the current study, extending Maine's current weight limits should consider quid pro quo options that would sunset outdated equipment and provide greater control over the types of equipment used for high weight loads. One option that might be considered is a permit system that would provide incrementally higher weight limits to equipment that has proven to provide better handling and incur less damage to road infrastructure. Examples of equipment options that could be considered under such a permit system are:

    - 6 axle TST combinations, with fixed axles (no lift axles) and air-ride suspension
    - On board scales capable of providing individual or axle group loadings
    - Load axles equipped with dual tires (no super singles)
    - Permit issuance could be made conditional upon receiving (and maintaining) a satisfactory" safety rating from a Compliance Review within the past year.
    - Other advanced vehicle technologies such as collision avoidance sensors or on-board recorders for hours of service could also be contemplated.

‡‡‡ *Comprehensive Truck Size and Weight Study: Vol. III Scenario Analysis*, USDOT, August 2000., pp. VIII-12.

Study Conclusions

The analysis assumes that extending the current federal truck weight exemption on the Maine Turnpike to currently non-exempt Interstate Highways in Maine would divert five and six axle TST combinations over 80,000 lbs. from the Turnpike and non-Interstate highways. **Exhibit 43** summarizes the economic impacts that would result from extending the current federal weight exemption on the Maine Turnpike to currently non-exemption portions of the Maine Interstate System.

Exhibit 43: Impacts of Exempting Currently Non-Exempt Maine Interstate Highways

Safety Economic Impacts	$356,000
Pavement (Low)	$1,001,866
Pavement (High)	$1,651,189
Bridge	$316,869
Annual Savings - Low	**$1,674,735**
Annual Savings - High	**$2,324,058**

The economic impact in Maine that would result from extending an exemption from federal GVW limits to currently non-exempt Interstate Highways in Maine is estimated to be annual cost savings of between $1.7 and $2.3 million. Extending a federal weight exemption to currently non-exempt Maine Instate Highways is projected to increase highway safety, reduce pavement and bridge maintenance, increase private sector transportation efficiency and produce societal benefits. The societal benefits for towns and cities in Maine will come largely in the form of reduced traffic congestion, as well as less noise and air pollution.

End Notes:

[1] *A Heavy Haul Network for the State of Maine – HHTN Identification and Needs Assessment* – Final Report. Wilbur Smith Associates, November 26, 2001

[2] *A Heavy Haul Network for the State of Maine – HHTN Identification and Needs Assessment* – Final Report. Wilbur Smith Associates, November 26, 2001

[3] Federal Motor Carrier Safety Administration (FMCSA); Analysis Division: *Large Truck Crash Facts 2001*, January 2003.

[4] *Comprehensive Truck Size and Weight Study: Vol. III Scenario Analysis*, USDOT, August 2000. pp. VIII-3.

[5] Roberts, Freddy L., and Djakfar, Ludfi:. " Preliminary Assessment of Pavement Damage Due to Heavier Loads on Louisiana Highways" Louisiana Transportation Research Center, May 1999. pp. iii.

[6] TMS Consultants, LLC; LONCO INC.; Hook Engineering; Dr. George Hearn: Non-Divisible Load Study, Colorado DOT, May 2001. Executive Summary, online at: http://www.tmsconsultants.com/NondivLoadStudy.htm

[7] MaineDOT Response to Comments on Draft "Study of Impacts caused by Exempting Currently Non-Exempt Maine Interstate Highways from Federal Truck weight Limits." http://www.maine.gov/mdot/freight/

ENGINEERS
PLANNERS
ECONOMISTS

Wilbur Smith Associates